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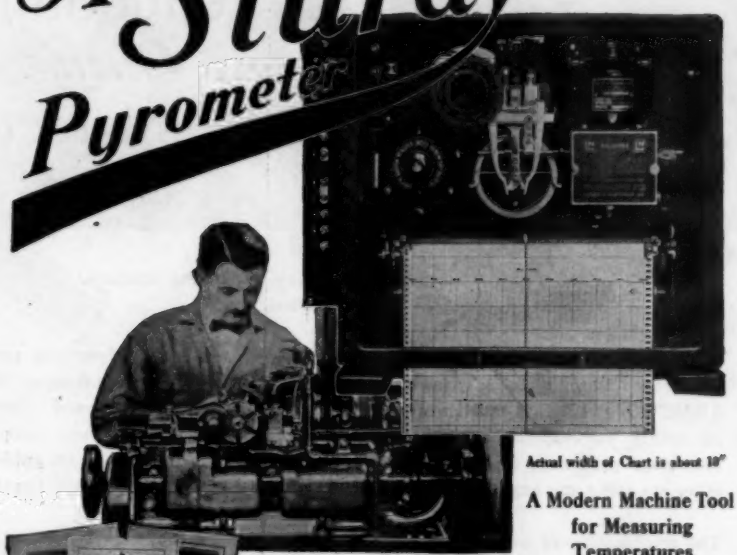

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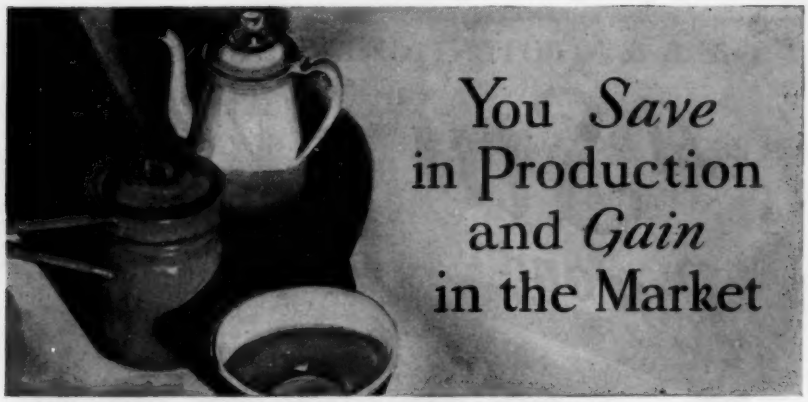

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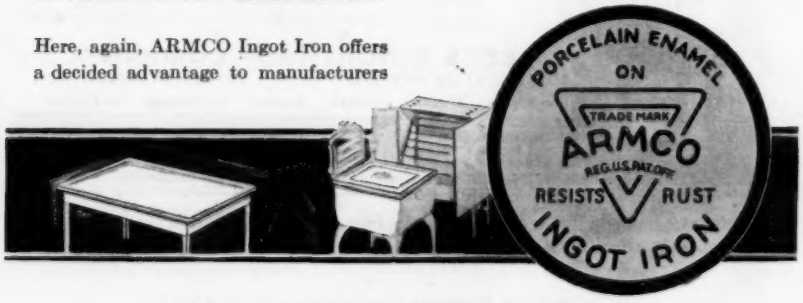

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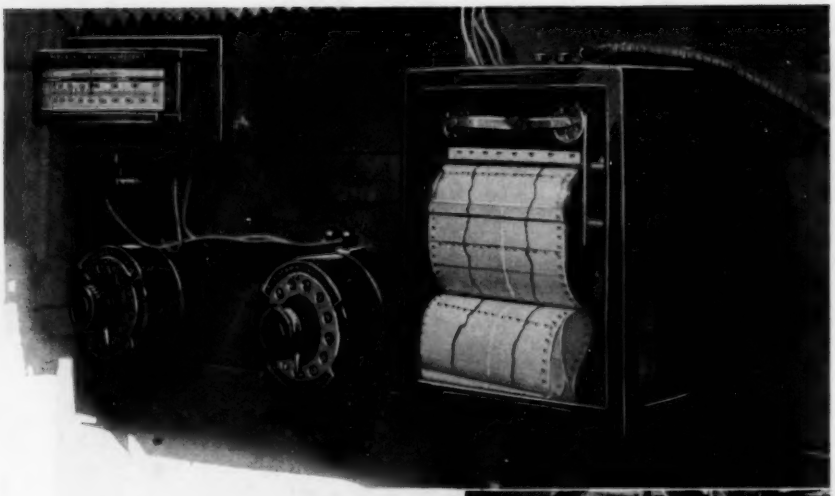

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DETERMINATION OF THE SOURCE AND MEANS OF PREVENTION OF STONES IN GLASS

By Herbert Insley[1]

ABSTRACT

The microscopic characteristics of different crystalline materials occurring as stones or lumps in glass are described and photomicrographs of stones originating from devitrification of the glass, incomplete solution of batch constituents, and incorporation in the glass of refractory wall material are reproduced. Methods of determining the location in the glass-making system of the source of stones, using microscopic as well as other methods, are given. Means of prevention or elimination of the stones are suggested.

Introduction

In glass, "stones" are segregations of undissolved or crystallized material. The petrographic microscope has been found to be the only instrument which is generally useful in identifying the crystalline compounds in these stones. The optical constants, the general types, and the methods of identification of stones in glass have been reported in previous papers.[2] It is the purpose of this paper to show how the nature of the crystal assemblages, the shape and size of the crystals, and the amount of reaction between the stones and the molten glass indicate in what manner and from what material sources these stones originate and where in the glass-making operations they first appear. Possible methods for the prevention of different types of stones will also be discussed.

According to their source stones may be of three types: devitrification stones, batch stones, and refractory stones. Devitrification stones are the result of the crystallization of one or more of the constituents of the glass itself. Batch stones are due to the incomplete solution in the molten glass of one of the constituents of the batch. Refractory stones have their source in the walls of the pot or tank and they are introduced into the melt by spalling or by selective solution of the refractories.

Devitrification Stones

Crystallization in the glass, resulting in devitrification stones, is caused by improper batch compositions, improper temperatures in those stages of the manufacturing process where crystallization takes place, or by nonuniformities of composition within the melt. The local composition and temperature determine, of course, what compound, if any, will crystallize at any given point in the melt.

The accompanying photomicrographs of sections of devitrification

[1] Published by permission of the Director of the Bureau of Standards of the U. S. Department of Commerce. Received February 11, 1929.

[2] N. L. Bowen, *Jour. Amer. Ceram. Soc.*, **1** [9], 594–605 (1918). Herbert Insley, *Ibid.*, **6** [6], 706–16 (1923); *Ibid.*, **7** [1], 14–18 (1924).

stones (Figs. 1, 2, 3, 4, and 5) show the different structures which are characteristic of the compounds crystallizing and of the conditions under which crystallization takes place.

Tridymite Figure 1 is a portion of a spherical group of minute tridymite (SiO_2) crystals. Many of these spherical aggregates, each from one to two centimeters in diameter, were formed in a random arrangement in a mass of glass which had lain for several days in the flow spout of a bottle glass tank at an estimated maximum temperature between 1100°C and 1200°C. Evidently crystallization in this case can be ascribed to the long heat treatment to which the glass was subjected.

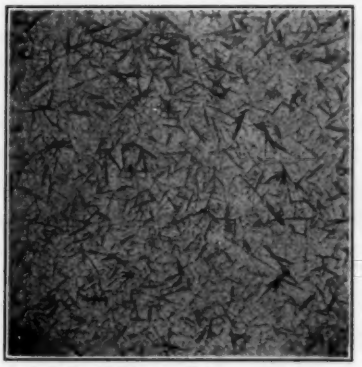

FIG. 1.—Hexagonal plates of tridymite (turned on edge) embedded in bottle glass. Magnification, 50 ×. Ordinary light.

FIG. 2.—Section of a mass of wollastonite crystals from the bottom of a tank. Magnification, 35 ×. Nicols crossed.

Wollastonite Figure 2 shows a thin section of wollastonite ($CaO \cdot SiO_2$) "dog" taken from the bottom of a sheet glass tank after the tank was shut down for repairs. The laminated appearance was produced by a series of fine threads which are composed of innumerable minute crystals of wollastonite. This structure indicates that crystallization was fairly rapid.

Diopside Figure 3 is a photomicrograph of a section of scum removed with a ladle from the melting surface of a sheet glass tank. Dolomitic limestone was used in the batch and consequently the crystals formed were diopside ($CaO \cdot MgO \cdot 2SiO_2$) instead of wollastonite ($CaO \cdot SiO_2$), the related compound which may crystallize when nonmagnesian limestone is used.

$Na_2O \cdot 3CaO \cdot 6SiO_2$ The compound $Na_2O \cdot 3CaO \cdot 6SiO_2$ has been found in several instances in plate and sheet glass. It may occur as large masses in the bottom of the tank or as individual crystals

scattered through the finished sheet. Figure 4 shows a section taken from a mass of this material collected from the bottom of a tank. The radiating, feathery habit indicates either that crystallization was rapid or that the glass was unusually viscous.

Jeffersonite In a glass used for making amber glass tubing with an automatic machine, a crystalline material was formed which appeared in the tubing as clots. A microscopic examination of this material showed it to be Jeffersonite (Fig. 5), a compound related to diopside but which contains varying amounts of zinc and manganese. The glass itself contained oxides of iron, zinc, manganese, and magnesium as well as the customary soda, lime, and silica.

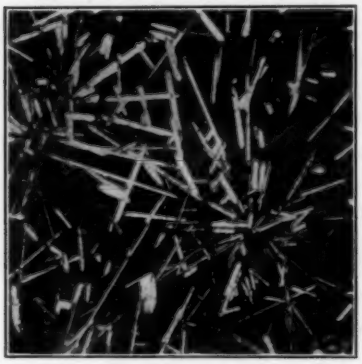

FIG. 3.—Diopside crystals in scum on the melting surface of a sheet glass tank where magnesian limestone was used in the batch. The prismatic crystals show a tendency to radial arrangement about centers. Magnification, 70 ×. Nicols crossed.

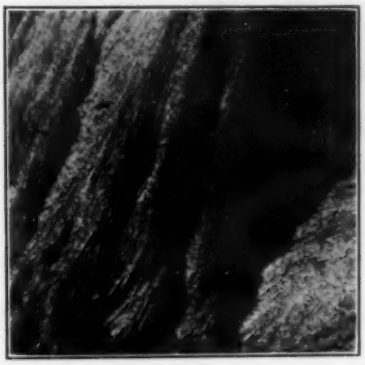

FIG. 4.—A mass of crystals of $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ removed from the bottom of a sheet glass tank. Magnification, 35 ×. Nicols crossed.

Occurrence The detection of the place in the manufacturing process at which crystallization first occurs is of great importance in determining what steps should be taken to eliminate it. The microscope offers little aid in this connection. Usually, the only method possible is to trace the devitrification from the point at which it is first seen back toward the melting operation, taking samples frequently and systematically.

Cause When devitrification takes place along cords in the glass, it is probably caused by a higher concentration of one constituent in the cord than in the adjacent glass. In this case elimination of the cords may stop the devitrification. Nonuniformity of the batch or entrainment and remelting of scum are known causes of cordiness.

Random distribution of devitrification stones throughout a glass melt indicates either that the composition of the glass is too high in the constituents crystallizing or that the glass is allowed to remain too long at temperatures favorable to crystallization. In the soda-lime-silica glasses containing only very small amounts of other oxides the nature of the compound crystallizing may be determined with the microscope and by reference to the equilibrium diagram[3] of the system Na_2SiO_3–$CaSiO_3$–SiO_2 (Fig. 6), the necessary direction of change of the glass composition can be determined. In general the composition should be changed in the direction of falling temperatures indicated by arrows on the lines in Fig. 6. For instance, the point X (Fig. 6) represents the com-

FIG. 5.—Jeffersonite crystals formed in glass tubing made with an automatic machine. Magnification, 180 ×. Ordinary light.

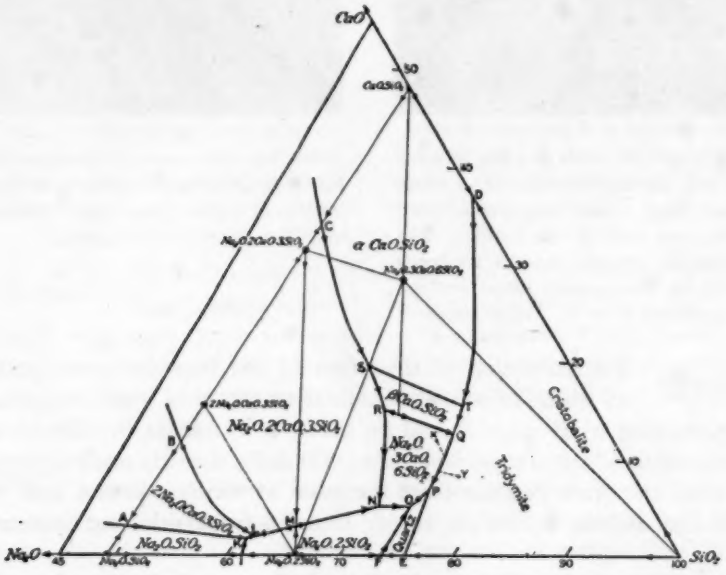

FIG. 6.—Crystallization diagram of the system $Na_2O{\cdot}SiO_2$–$CaO{\cdot}SiO_2$–SiO_2* on a weight per cent basis. Arrows indicate directions of falling temperatures.

[3] Morey and Bowen, *Jour. Soc. Glass Tech.*, 9, 226–62 (1925).

* Modified from Morey and Bowen, *Ibid.*, 9, 226–64 (1928).

position of a window glass. If manufacturing conditions are such that this glass must be held at temperatures just below 1000° for some time, devitrification may take place with separation of crystals of $Na_2O \cdot 3CaO \cdot 6SiO_2$. By changing the composition of the glass from X along the dotted line, the temperature at which crystallization takes place will be lowered and devitrification may be prevented. In the same way a bottle glass composition represented by the point Y may be changed along the dotted line to prevent crystallization of tridymite. When change in composition

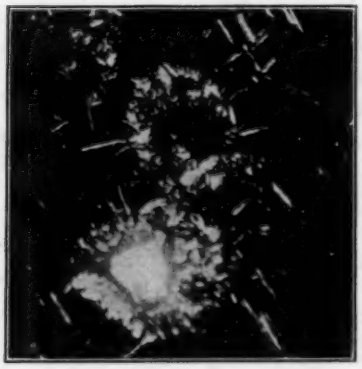

FIG. 7.—Section of a stone containing undissolved sand grains from the batch. The quartz is largely transformed to tridymite, bright remnants of quartz grains remaining in two circular areas. The radiating needles are cross-sections of tridymite plates resulting from an increased concentration of silica caused by a partial solution of the adjacent sand grains. Magnification, 70 ×. Nicols crossed.

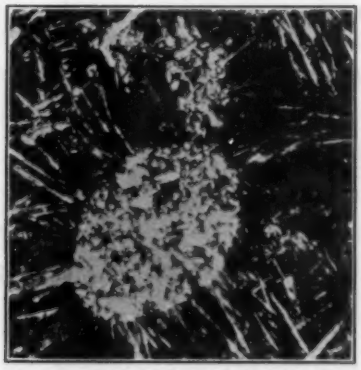

FIG. 8.—Section of the upper portion of the scum from the melting surface in a bottle glass tank. The circular areas filled with wedge-shaped twins of tridymite probably represent undissolved sand grains. Magnification, 35 ×. Nicols crossed.

is not feasible, devitrification may frequently be prevented by raising the temperature slightly at the place where crystals occur and allowing the glass to cool rapidly through temperatures favorable to crystallization farther on in the glassmaking process.

Batch Stones

Batch stones are caused by the incomplete solution of one of the batch constituents. Undissolved sand is by far the most usual source of such stones, although other sources such as lumps of lime and segregations of coloring constituents have been found. The quartz composing the cores

of batch stones may be converted to tridymite or cristobalite or it may remain unchanged, depending upon the length of time it is in the high temperature zone of the tank. Figure 7 shows a section of a batch stone containing circular areas with centers composed of quartz and outer portions composed of wedge-shaped tridymite twins. The needles radiating from the circular areas are cross-sections of tridymite plates which crystallized from the highly siliceous glass in the vicinity of the partially dissolved sand grains.

Where clay is used as the source of alumina in glass, batch stones sometimes result because of coarse grinding or balling of the clay. Their microscopic characteristics will be discussed with those of tank block stones which they resemble.

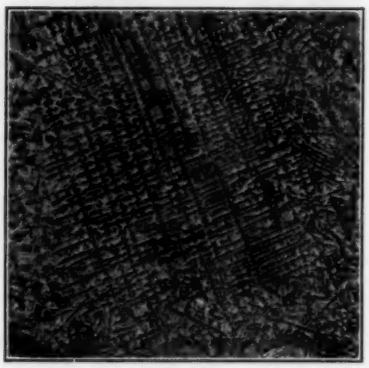

FIG. 9.—Section from the lower portion of scum from the melting surface in a bottle glass tank showing devitrification crystals of cristobalite. Magnification, 50 ×. Ordinary light.

Four possible means of prevention of batch stones are:

(1) Finer grinding of the batch
(2) More intimate mixing of the batch constituents
(3) Higher melting temperatures
(4) Longer melting time

The scum so frequently found on the surface of the glass near the bridge in the melting chamber of bottle glass tanks is caused by a combination of undissolved sand, devitrification products in the resulting highly siliceous surface of the melt, and drops falling from the silica brick crown of the tank. Figure 8 shows the upper portion of such a scum collected from the surface of the glass in a tank after a shutdown. Note the roughly circular areas filled with small tridymite twins and surrounded by platy crystals of tridymite. The formation of wedge-shaped tridymite twins is characteristic of the quartz to tridymite inversion, while the formation of plates is generally the result of crystallization from solution. The diameter of these roughly circular areas is only slightly less than that of sand grains usually used in the batch. A typical section of the lower portion of the scum is seen in Fig. 9. Here the scum is composed almost entirely of cristobalite.

Refractory Stones

Refractory stones are derived from the walls of the containing vessels in which the glass is made. These vessels may be the melting tank, the flow spouts, or the pots or tanks from which glass is fed to the machines.

Two general types of stones derived from clay refractories can be recognized: (1) those from above, and (2) those from below the glass surface.

Clay walls above the surface of the glass are attacked by the volatilized soda in the furnace atmosphere and by batch dusts composed largely of soda and lime. In the high temperatures of the melting chamber, corundum (Al_2O_3) and an alkali-aluminum-silicate liquid are the result of the reaction between the clay and the alkalis[4] unless the clay block is extremely siliceous, and then the liquid silicate may be the only product of the reaction. Where faces of the clay block slope in the appropriate

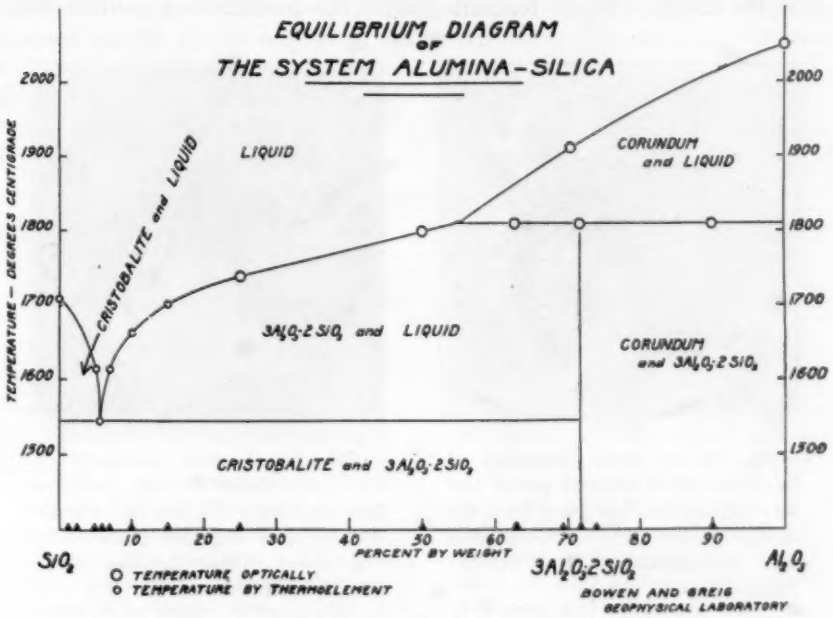

FIG. 10.—Equilibrium diagram of the system Al_2O_3–SiO_2.*

direction, the liquid silicate may flow into the molten glass carrying the crystals of corundum. Since corundum is not easily soluble in molten glass, these crystals frequently persist in the finished glass as stones.

The reaction between clay blocks and molten soda-lime glass where they are in contact is similar to that between clay blocks and the alkaline atmosphere of the furnace. Apparently, in both cases the effect of the alkali, and probably of the lime, is to lower very markedly the temperature at which aluminum silicates dissociate into corundum and liquid and to permit this dissociation to take place in compositions fairly high in silica. In the system containing only Al_2O_3 and SiO_2 (Fig. 10), mixtures with

[4] *Jour. Amer. Ceram. Soc.*, **6** [6], 713 (1923).

* From Bowen and Greig, *Ibid.*, **7**, 242 (1924).

more than 55% Al_2O_3 dissociate into corundum and liquid at 1810°C under equilibrium conditions. Microscopic examination has shown[5] that the dissociation into corundum and liquid takes place in fired clay in contact with soda-lime glass when the temperatures are those of commercial melting practice (below 1550°C) and when the clay block contains less Al_2O_3 than the molecular ratio $Al_2O_3 \cdot 2SiO_2$.

A small amount of molten soda-lime glass penetrating into the clay walls or into the clay stones floating in the glass acts as a flux which induces an increase in the size of the mullite ($3Al_2O_3 \cdot 2SiO_2$) crystals. At the same time the siliceous liquid remaining after the formation of mullite from

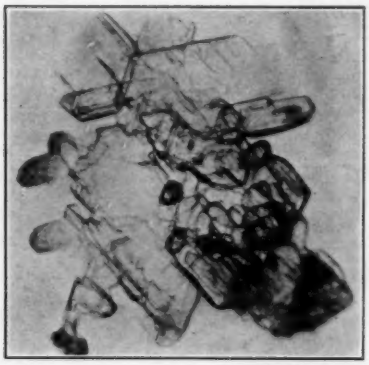

FIG. 11.—A stone composed of large corundum crystals which had been carried into the glass from the surface of clay blocks above the glass line. Magnification, 18 ×. Ordinary light.

FIG. 12.—A stone composed entirely of nephelite crystals caused by long-continued reaction between the molten glass and clay originally in the stone. Magnification, 45 ×. Nicols crossed.

the clay diffuses into the soda-lime glass. Continued action may lower the dissociation temperature sufficiently to cause solution of the mullite and simultaneous crystallization of corundum, except infrequently when the clay block contains so much silica that corundum cannot be formed and solution of the mullite leaves only liquid. The liquid developed by the crystallization and later dissociation of mullite may partially crystallize as nephelite ($Na_2O \cdot Al_2O_3 \cdot 2SiO_2$). The fact that nephelite so frequently occurs as skeleton crystals surrounding mullite or corundum suggests that it forms during the cooling of the glass and not at maximum temperatures.

Location of Source of Stones

The location of the source of refractory stones may be approximately determined from the size and nature of the crystals in them. Stones from blocks above

[5] *Jour. Amer. Ceram. Soc.*, **7** [8], 586–87 (1924); *Ibid.*, **9** [10], 638 (1926).

the glass line usually are composed only of corundum (Fig. 11). Sometimes nephelite is present and rarely large mullite crystals. The corundum crystals are always relatively large (more than 0.5 mm. in width). A stone in which even the corundum has disappeared and only the reaction product, nephelite, remains is shown in Fig. 12. Stones from tank blocks below the glass line in the hotter parts of the tank and clay stones from the batch are made up largely of corundum crystals with well-developed mullite needles sometimes present. The corundum crystals from blocks below the glass line are always smaller than those from tank blocks above the glass line and are frequently very minute (Fig. 13). If the clay contained quartz grains originally, these are usually completely dissolved.

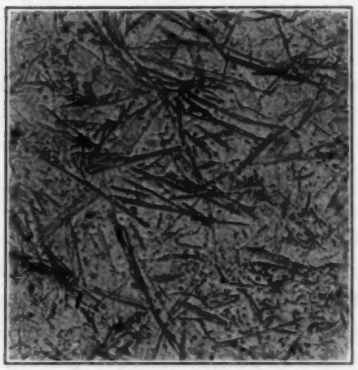

FIG. 13.—A stone derived from a clay block below the glass line in the melting end of a tank. Reaction between the clay and the molten glass has been so extensive that the stone is composed very largely of minute plates of corundum. Magnification, 240 ×. Ordinary light.

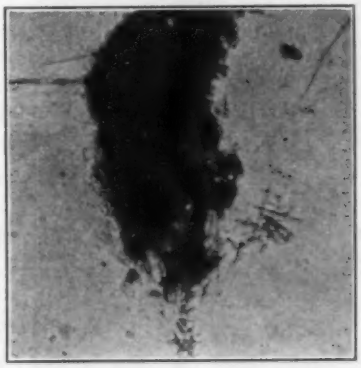

FIG. 14.—A clay stone which has undergone some reaction with the molten glass. The quartz grains at the boundary of the stone are rounded and a few large mullite crystals have developed and separated from the main mass of the stone. Magnification, 100 ×. Ordinary light.

In general, the crystals in such stones are not aggregated but are somewhat dispersed. Nephelite is frequently associated with the corundum.

Stones from blocks in such cooler parts of the system as the refining end of the melting tank, the flow spouts, and the machine-feeding pots and tanks show much less reaction with the molten glass. A few minute corundum crystals may be found at the outer border of the stone, and quartz grains in the clay frequently remain undissolved. Mullite crystals may be large or small, but generally are in closely packed masses and show little tendency to be separated from the main mass of the stone except at the outer edge. Figure 14 shows a stone in which a small amount of reaction and solution has taken place. The quartz grains at the outer

border of the stone are rounded and partially dissolved and a few large mullite needles have developed and floated away in the glass. The stone shown in Fig. 15 has been affected very little by the molten glass. Sharp corners have been rounded off, but no crystalline reaction products have been formed.

In melting operations using a batch containing clay there seems to be no microscopic method of distinguishing between clay stones from this source and stones given off by refractory blocks in the melting end of the tank. Both are very similar in microscopic appearance and in crystalline compounds formed. Once having determined with the microscope that the stones came from either of these two sources, a knowledge of the condition of the tank refractories and of the way the batch is mixed and ground must be relied on to make the distinction.

FIG. 15.—A clay stone which has undergone very little reaction with the molten glass. Magnification, 160 ×. Ordinary light.

Microscopic examination of tank block stones gives evidence of their point of origin in the glassmaking system, but it gives no information as to how such stones may be eliminated. Usually, the offending blocks are either replaced, or backed with some sort of cooling arrangement.

Stones from blocks above the glass line are particularly annoying since large crystals of corundum dissolve very slowly in molten glass. The greater the height to which clay walls extend above the glass line, the greater the danger from these highly insoluble stones. In designing tanks, consideration should be given to the advantages of eliminating clay blocks above the glass line on the side walls, the end of the melting chamber, and the bridge wall.

CORRECTION OF AN EXTREME CASE OF CRACKING IN THE DRYING OF BRICK[1]

By Howells Fréchette and J. G. Phillips

ABSTRACT

I. In the manufacture of stiff-mud brick from a highly colloidal clay of low permeability to water, drying breakage was extremely high even though the drying was conducted at a very slow rate under high humidity conditions. Laboratory investigation yielded two methods of correcting the faults: (1) Preheating the clay for half an hour at a temperature between 400 °C and 500 °C increased the permeability to such an extent that brick made from the preheated clay could be dried rapidly without cracking. (2) Coagulating chemicals, such as aluminium chloride, ferric chloride, sodium chloride, and hydrochloric acid, in conjunction with moderate additions of grog, increased the permeability and thus improved the drying properties of the clay. II. Plant scale tests using ferric chloride, sodium chloride, and grog resulted in the production of brick which could be dried safely in a reasonable time. The fired brick were improved in quality as to strength and color. III. The chemical treatment of the clay using 1% ferric chloride and 0.5% sodium chloride with 10 to 15% grog was adopted for plant operation and resulted in increased production, lower cost of manufacture, and improved quality of product.

In the manufacturing of brick, the drying operation is not always the source of the most serious problems of the process. In some plants the drying department demands very little attention. The managers of such will find it hard to visualize the conditions at a brick plant in Alberta, Canada, with which we have recently had to deal.

Throughout the Great Plains region of Canada there are very extensive areas in which the only materials for brick manufacture are clays and shales of exceptionally poor drying properties. Calgary and Winnipeg, the two principal consuming centers of our Prairie Provinces, lie within such areas. The demand for brick has been so great and the freight from other districts so high that plants have been established at and near these cities to manufacture brick from the local clays and shales. While serious trouble, due to breakage in drying, was encountered at most of the plants, in submitting some data of an investigation recently completed, a description of conditions at one locality only will be presented.

Redcliff, Alberta, is a small village 170 miles east of Calgary, on the main transcontinental line of the Canadian Pacific Railway. It is situated on the plateau overlooking the South Saskatchewan River. The river has cut a deep, wide valley through the shales of the Belly River formation and has exposed them near the top of the escarpment where they may be

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received December 24, 1928.

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readily obtained for brickmaking. As Redcliff has an abundant and very cheap supply of natural gas, the site appears to be excellent for brick manufacture and the clays available are satisfactory except that they have an extreme tendency to crack when any attempt is made to dry them at a reasonably rapid rate.

Description of the Clay

The clays include two general types. A soft clay, containing varying amounts of sand and limestone pebbles, occurs as a heavy overburden on a rather soft, very fine-grained shale. This shale, which is massive and lacks the typical bedding partings, on exposure to the weather crumbles as it dries into very small, angular granules and when wetted slakes to a very greasy clay. In the laboratory it has been found practically impossible to dry briquets made of this shale without cracking. It is used for the production of dry-pressed brick at three plants, but so great is the tendency to crack during drying that an extremely long water-smoking period has been found necessary in order to prevent the development of hair cracking in the brick during the elimination of the small amount of tempering water. The dry-press method cannot be regarded as thoroughly satisfactory either in respect to operation or the quality of the product.

One plant at Redcliff uses the stiff-mud process, producing drain and structural tile and common and face brick. For the tile and common brick, the soft clay is used. While it possesses a strong tendency to crack in drying, in this respect it is not so bad as the shale. Ware made from it alone is of a poor red color, is marred by limestone pops, and lacks density.

It has been the practice, in making face brick, to use a mixture of about 60% clay, 25% shale, and 15% brick dust. The addition of the shale improves both the color and the density of the brick but greatly increases the difficulty of drying the ware.

The brick were dried in from seven to eight days in a 115-foot gas-fired, radiated-heat drier with very high humidity. Even with this slow and most gentle drying the breakage was excessive. The rejects after drying ranged from 40 to 50%. Practically all of the remainder, those that went to the kilns for firing, were defective due to reticulating cracks which were barely noticeable to the eye but lowered the strength and frost resistance of the finished product.

Incidental to a general investigation on the tender-drying clays of the Prairie Provinces, a thorough study was made of the problem of drying stiff-mud face brick for the company at Redcliff, with a view to devising a means of drying their ware safely and quickly.

Humidity drying had been given a thorough trial and had failed.

Treatment to Overcome Drying Cracking

A review of the literature brings out three methods of treatment for remedying troublesome drying properties of clays.

(1) The use of some nonplastic material such as sand or grog, which would reduce shrinkage and provide for an easier capillary travel of the water to the surface of the brick.

(2) A heat-treatment of the clay, prior to molding, to destroy its colloidal property to such an extent that it would be much more permeable to water.

(3) The treatment of the clay by chemical coagulants.

Grog Tests showed that the use of grog within working limits would not effect the results desired. Had the clay been tender-drying due to abnormally high shrinkage, the use of grog might have served the purpose, but in this case the trouble was due to the impermeable character of the body. There is such a high percentage of colloidal matter present that great resistance is offered to the flow of water from the interior to the surface of the brick during drying. The drying, and consequently the shrinkage, progresses much more rapidly at the surface than within the brick. This causes shrinkage strains which result in the development of cracks.

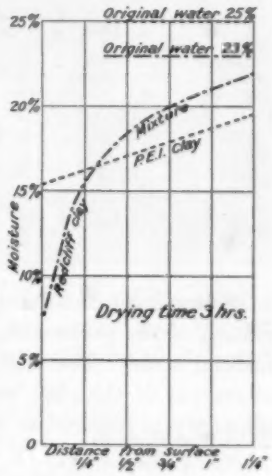

FIG. 1.

Figure 1 shows the progress of drying from the surface to the interior of brick made from the Redcliff clay mixture (50% surface clay, 50% shale) and from a normal, good-drying, though fine-textured clay from Prince Edward Island. The two bricks were subjected to the same drying conditions, at the same time. The almost straight line of the Prince Edward Island clay shows the effect of low resistance to the internal flow of water.

Preheating The heating of a clay causes an alteration of its physical properties. The most noticeable change is loss of plasticity. Coincidental with the loss of plasticity is the development of a harsher, more granular texture. These changes do not take place suddenly at a critical temperature, but are gradual over an appreciable temperature range.

Several writers have pointed out that a properly controlled heat-treat-

ment, or preheating as it has been termed, could be made use of to improve the drying properties of clays.[2]

To determine the applicability of this preheating treatment to the Redcliff clay mixture,[3] a series of tests was made in the laboratory.

Previous investigators on the preheating of clays have shown that the effective temperature range of different clays varies. In the case of the Redcliff clay it was found that when preheated to temperatures between approximately 400°C and 500°C, it showed decided alteration in working properties. Much of the stickiness had disappeared and full-sized brick made from it could be dried safely at a fairly rapid rate.

In all preheating tests dry clay which had been ground to pass an 8-mesh screen was used and the temperature rapidly raised to the desired point, then held for half an hour and quickly cooled.

The following table shows data obtained from the preheating experiments:

TABLE I
PREHEATING TESTS ON REDCLIFF MIXTURE
(Clay 50%, shale 50%)

Preheat temp., °C ½ hr.	Drier temp., °C	H_2O plasticity (%)	Air shrinkage (%)	Remarks
Untreated	65	28	7	Very bad cracking
350	65	28	6.5	Some improvement but still very bad cracking
400	65	27	6.0	A great improvement; only a slight cracking; working properties much improved
450	65	26	6.0	No cracking whatever
500	65	22	4.0	Plasticity slightly too much reduced; no cracking whatever

Preheating can solve the problem as far as correcting the drying difficulties, if the preheating itself can be successfully carried out on a commercial scale. The tests show that below 400°C there is not sufficient alteration of the clay to permit safe rapid drying, and above 500°C the plasticity is reduced to so great an extent that the clay is somewhat too

[2] A. V. Bleininger and F. E. Layman, "A Method of Making Possible the Utilization of an Illinois Joint Clay," *Trans. Amer. Ceram. Soc.*, **11**, 354 (1909).

A. V. Bleininger, "The Effect of Preliminary Heat Treatment upon Clays," *Ibid.*, **11**, 392 (1909).

Edward Orton, Jr., "Experiments on the Drying of Certain Tertiary Clays," *Ibid.*, **13**, 781 (1911).

A. V. Bleininger, "Notes on the Preheating of Clays," *Ibid.*, **12**, 504 (1910).

R. K. Hursh, "Preheating Temperature and Volume Shrinkage, *Ibid.*, **14**, 811 (1912).

Joseph Keele, "Drying Defects in Some Cretaceous Clays of the Great Plains Region of Canada," *Ibid.*, **14**, 152 (1912).

Joseph Keele, "Experiments in Preheating Clays," report on the clay and shale deposits of the Western Provinces, Dept. of Mines of Canada, Memoir No. 25, p. 83 (1913).

[3] Throughout the investigation a mixture of one part of the surface clay and one part of shale was used. This was the mixture most desirable from an operating standpoint.

short in texture. This is a narrow temperature range for rotary kiln operation, but with uniform clay feed and close attention it is probable that it could be adhered to. The process would entail a heavy expenditure for plant and would require considerable experimentation to adjust the flow of clay, temperature of operation, etc.

It is almost twenty years since Bleininger advocated the use of preheating for tender-drying clays, but a very thorough inquiry in Canada and the United States resulted in locating only one plant where preheating had been given a trial. At this plant, located at Estevan, Saskatchewan, the experiment was not a success. From what meager information is available now, the failure would seem to have been due to faulty design of plant and should not condemn the preheating method.

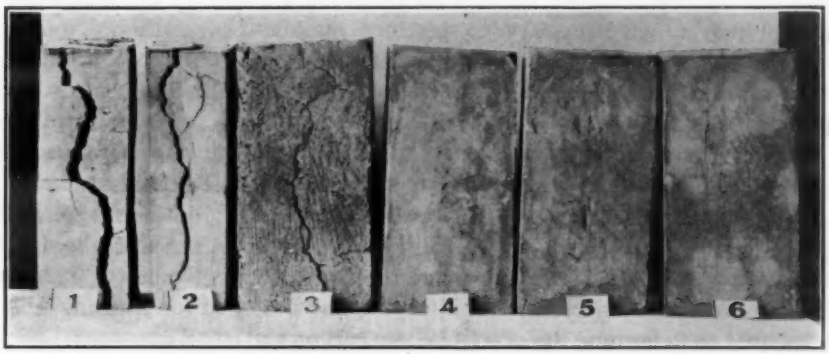

FIG. 2.—Laboratory test bricks dried at 65°C. Redcliff clay mixture (surface clay 50%), shale 50%: (1) untreated, (2) 0.5% hydrochloric acid, (3) 33% grog, (4) 33% grog + 0.4% hydrochloric acid, (5) 33% grog + 1% ferric chloride, (6) 33% grog + 1% aluminium chloride.

It was attempted to dry and preheat the clay in one kiln in one operation, which is impossible with a sticky wet clay such as was used.

Chemical Treatment

Certain chemicals when added in small percentage to a clay have a flocculating or coagulating action, causing the clay particles to build up small aggregates and virtually making the clay coarser in texture.[4] Experiments were made with a

[4] Homer F. Staley, "Effect of Salts on Drying Behavior of Some Clays," *Trans. Amer. Ceram. Soc.*, **17**, 697 (1915).

N. B. Davis, "The Effect of Lime on Certain Cracking Clays," *Ibid.*, **17**, 497 (1915).

Edward Orton, Jr., *loc. cit.*

Robert Back, "The Effect of Some Electrolytes on Clay," *Ibid.*, **16**, 515–16 (1914).

A. V. Bleininger, "The Effect of Acids and Alkalis upon Clay in the Plastic State," *Ibid.*, **14**, 827 (1912).

C. H. Kerr and C. E. Fulton, "The Effect of Some Electrolytes on Typical Clays," *Ibid.*, **15**, 184 (1913).

number of coagulating chemicals to determine their effect on the drying properties of the clay, the percentage required to attain certain results, and their general effect on the finished brick. In the selection of chemicals to be tried, cheapness was a prime consideration.

As a preliminary test the flocculating effect of a number of chemicals was studied. Into each of a series of settling tubes two grams of clay were placed. The various chemicals were then added in proportion of 0.5, 0.8, 1.0, 2.0, and 3.0% of the weight of the dry clay, making a series of five trials for each chemical. A fixed amount of distilled water was added to all the tubes, which were then shaken for five minutes. The tubes were allowed to stand for one hour after shaking and the amount of settle measured. These tests brought out very well the comparative coagulating power of the various chemicals, and also gave an indication of the percentage necessary to produce marked coagulation. Among the chemicals which gave particularly good results was ferric chloride. The writers find no record of previous investigators having used it for this purpose.

Bricks were made in which were incorporated varying percentages of the chemicals which the previous tests had shown to possess marked coagulating effect on the clay. Bricks were also made with these chemicals and varying percentages of −16-mesh grog. The additions of chemical and grog were kept within the range of economic practicability. These bricks were then subjected to rapid drying and observed for cracking, and later fired to determine the effect of chemicals on the color, etc.

TABLE II

CHEMICAL AND GROG TESTS ON REDCLIFF MIXTURE

(Clay 50%, shale 50%)

Grog (16M) (%)	Chemical	Per cent added	Drier temp., °C	Results
33			65	Brick and briquets cracked very badly
25			"	Brick badly cracked
	$FeCl_3.6H_2O$	2.0	"	Brick showed cracking
25	"	1.5	"	Brick showed no cracking
33	"	1.0	"	Brick did not crack; dried very well
	NaCl	2.0	"	Brick cracked badly
25	"	2.0	"	Brick showed some cracking
25	"	4.0	"	Brick only very slightly cracked
33	$AlCl_3$	1.0	"	Brick showed considerable cracking
33	HCl	0.4	"	Brick dried very well; no cracking
25	HCl	0.5	"	Brick cracked badly

Effectiveness of Chemicals

The pertinent results obtained from this study of the effectiveness of additions of various chemicals, as well as additions of the chemicals in conjunction with grog in overcoming the drying defects of this clay, may be summarized as follows:

Four per cent of sodium chloride with 25% of grog made it possible

to dry brick of this clay in the laboratory at 65°C with only a very slight evidence of cracking. Sodium chloride in percentages higher than this would probably give trouble in firing.

One per cent of ferric chloride with 33% grog, or 1.5% of ferric chloride with 25% grog completely corrected the drying defects of this clay.

Four-tenths per cent hydrochloric acid with 33% grog corrected the drying defects of this clay, but with 25% grog and 0.5% hydrochloric acid there resulted bad cracking in the brick.

Aluminium chloride was found to be less effective than ferric chloride and was rejected as it is more expensive.

After firing the test pieces made of the various mixtures of Redcliff clay, chemicals, and grog, it was found that ferric chloride and sodium chloride reduce scumming. It was also noted that ferric chloride imparts a deeper red to the brick, thereby improving color.

Of the chemicals studied in this investigation, ferric chloride seemed the most promising. It was by far the most effective of the salts in overcoming the drying defects, and was found to reduce scumming and give a deeper red color to the brick which is desirable in the case of this clay.

Hydrochloric acid very effectively corrected the drying defects, but its corrosive action on metal parts would probably be an objectionable feature in the brick plant.

Ferric chloride was therefore selected as the chemical to be used in the plant tests.

Plant Trials

The laboratory investigation of the possibility of correcting the drying troubles by means of chemical treatment yielded such encouraging results that it was decided to conduct full scale tests at the brick plant at Redcliff.

In these tests all ingredients were carefully weighed and mixed by hand. The resulting mixtures of clay, grog, and chemical (when added dry) were shoveled into the feed bin from which they went to the pug mill and then through the auger-brick machine. The brick, set on cars, were immediately placed in the drier.

The driers at this plant, as already stated, were the radiated heat type, gas fired and, for the purpose of the tests, were speeded up so that the test brick would be subjected to a drying period of three or four days.

In laboratory tests on clays from Winnipeg, it was observed that while sodium chloride alone to be effective was required in such large percentage as to cause other troubles, when used in conjunction with ferric chloride, small additions would effectively replace some of the more expensive ferric salt. In view of this it was decided to use mixtures of the two chlorides in these plant tests at Redcliff.

Among the tests made the following will indicate the results obtained from varying percentages of grog and chemicals:

No. 1

Clay (surface clay 67%, shale 33%)		75%
Grog (brick bats ground to −8-mesh)		25%
Ferric chloride	1.0% } added dry	
Sodium chloride	0.5% }	

The brick came through the drier in four days, completely dry, and there was no evidence of any cracking.

No. 2

Clay (surface clay 67%, shale 33%)		80%
Grog (brick bats ground to −8-mesh)		20%
Ferric chloride	0.5% } added dry	
Sodium chloride	1.0% }	

The brick came through the drier in four days, completely dry. There was some cracking in a few of the brick. The improvement, however, over the former operating practice was great, as 90% of the brick showed no cracks whatever.

In these two foregoing tests difficulty was experienced in the grinding and handling of the ferric chloride due to its being somewhat deliquescent. Examination of the dried brick showed that considerable of the ferric chloride was segregated in spots, indicating that it had not been thoroughly dissolved and disseminated throughout the clay during pugging. In view of this fact it was decided to add the ferric chloride in solution in subsequent tests.

To do this the amount of water necessary to temper 3000 pounds of clay and grog was estimated and to it was added, and thoroughly dissolved, the exact amount of chemical to make the desired percentage in the clay mixture.

No. 3

Clay (shale only)		80% } mixed dry
Grog (brick bats ground to −8-mesh)		20% }
Sodium chloride	0.5%	
Ferric chloride	1.0% added in solution	

In this trial drying was accomplished in four days with no cracking.

No. 4

Clay (surface clay 50%, shale 50%)		85%
Grog (brick bats ground to −8-mesh)		15%
Ferric chloride	1.0% } added in solution	
Sodium chloride	0.5% }	

The brick were dried completely in three days with no cracking.

No. 5

In this test the brick were made from the mill-run mixture, consisting approximately of two parts surface clay, one part shale and from 10 to 15% of grog, and the chemicals were added in the pug water in the following percentage:

Ferric chloride	1.0%
Sodium chloride	0.5%

The brick were dried very satisfactorily in four days with no cracking.

Plant Results and Practice

These trials proved conclusively that the chemical treatment solves the drying problem of this clay; also that the amount of grog necessary is considerably less than had been anticipated.

After the brick made during the tests were fired it was found that the additions of chemicals had decidedly improved the color and had overcome the slight scumming seen in the regular run of brick manufactured at this plant. Another benefit derived from the chemicals is that they prevent the popping of the lime pebbles which occur in the surface clay.

In putting the chemical treatment process into regular operation, two tanks were installed, each of sufficient size to supply pugging solution for 4000 bricks. While solution is being delivered to the pug mill from one tank, the other is being replenished. Iron tanks and fittings were used at first, but as they corroded rapidly they were replaced by wooden tanks, lead piping, and acid-resisting valves.

The process has been in operation at the Redcliff plant for over six months and has given thorough satisfaction. The drying which used to require from seven to eight days has been reduced to three days and the drier loss from 40%, or more, to almost nothing. It has resulted in an increase of output from 24,000 to 40,000 bricks per day. Notwithstanding the high extra cost for chemicals, the cost of manufacture has been reduced and the product sells for an increased price owing to the improved quality.

SOME WASTE-HEAT DRIER CALCULATIONS AND CHARTS[1]

By A. E. R. Westman[2] and R. G. Mills[3]

ABSTRACT

Equations were developed which, when used in conjunction with hygrometric charts, enabled the usual waste-heat drier calculations involving heat supply and water removal to be performed by direct substitution. These equations were used in preparing charts showing the effect of (1) atmospheric humidity conditions, and (2) air discharge temperature on the operation of a typical waste-heat drier. The advantages which might result from the control of the initial moisture content of the air used in drying and the feasibility of using silica gel for this purpose are discussed. Changes in drier design which would permit higher exit temperatures for the air used in drying are suggested by the outcome of the calculations.

I. Introduction

(1) Purpose In the operation of indirectly heated, waste-heat driers, difficulties sometimes arise in damp weather due to the high moisture content, and therefore low water-carrying power, of the air drawn through the kilns. The possibility of drying large quantities of air with silica gel was shown by Edwin H. Lewis,[4] who described a commercial installation for drying the air used in a blast furnace. To determine the feasibility of using silica gel for drying air for waste-heat driers it was necessary to calculate the importance of atmospheric humidity conditions in the drier operation.

A second problem was that of determining the best exit air temperature for a drier. The moisture-carrying capacity of air increases rapidly with temperature and it appeared plausible that higher exit air temperatures than those commonly used would permit more efficient operation.

Arithmetic calculations[5] were not sufficiently convenient or comprehensive. It was found possible, however, to develop general algebraic equations which expressed the most important relationships concisely, and enabled the usual waste-heat drier calculations to be carried out conveniently and systematically, using direct instead of "cut and try" methods.

These equations will be presented and their generality and applicability discussed. The two problems stated will be solved by these equations and the relationships shown by charts.

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[1] Presented at the Annual Meeting, American Ceramic Society, February, 1929, Chicago, Ill. (Heavy Clay Products Division.) Received Jan. 23, 1929.

[2] Associate Professor and Research Associate, Dept. of Ceramics, Rutgers University, New Brunswick, N. J.

[3] Instructor, Department of Ceramics, Rutgers University.

[4] Presented at the Fall Meeting of British Iron and Steel Institute, Glasgow, Sept. 20–22, 1927. *Fuels and Fur.*, **5** [10], 1383–84 (1927) and *Ceram. Abs.*, **7** [1], 44 (1928).

[5] For an example see Clay Products Cyclopedia, p. 46, 1928.

(2) Scope Only progressive, waste-heat, car-tunnel driers were considered. Some of the equations are, however, capable of more general application as will be shown later. The calculations were limited also to the factors and conditions revealed in the heat and moisture balances of the drier.

A number of factors which would determine the best drier dimensions, such as the maximum rate of drying without cracking, the rate of heat and moisture transfer between the air and the clay, etc., were not included. Nor were the laws which govern the direction in which heat or moisture will flow under given conditions used in developing the equations. The conditions they impose and the practical significance of these conditions will be pointed out.

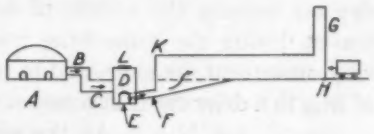

FIG. 1.—Type of drier under consideration.

The type of drier for which the equations were developed is diagramed in Fig. 1. The temperature of the air entering the fan D is controlled by admitting atmospheric air through the louvre L.

TABLE I

SYMBOLS USED

Air Temperatures (°F)

T_{fa}	Temperature of air at fan
T_{ha}	Temperature of hot air entering drier
T_{ca}	Temperature of cold air leaving drier

Brick and Car Temperatures (°F)

T_{cb}	Temperature of cold bricks entering drier
T_{hb}	Temperature of hot bricks and cars leaving drier

Moisture Contents of Air (lb. moisture per lb. of dry air)

M_{aa}	Moisture content of atmospheric air
M_{ca}	Moisture content of cold air leaving drier

Moisture Contents of Bricks (lb. moisture per lb. of dry clay)

M_{cb}	Moisture content of cold bricks entering drier
M_{hb}	Moisture content of hot bricks leaving drier

Car Iron (lb. iron per lb. of dry clay)

I	Weight of iron in a drier car divided by weight of dry clay carried by a car

Thermal Data (B.t.u./lb./°F)

H	Quantity of heat required to convert one pound of water at T_{cb} into steam at T_{ca} (obtained from hygrometric charts or tables)
0.11	Specific heat of car iron B.t.u./lb./°F
0.25	" " " dry clay " " "
0.24	" " " dry air " " "
0.48	" " " steam " " "
1.10	Factor by which heat requirement of drier was multiplied in order to allow for heat losses, which were assumed to be 10% of net heat requirement

Air Supply for Drying (lb. dry air per lb. dry clay)

A_{mc}	Amount of air required for moisture carrying, neglecting heat-supply requirements
A_{hs}	Amount of air required for heat supply, neglecting moisture-carrying requirements

II. Development of Equations

(3) Definition of Terms and Symbols The term "air" designates the drying medium, "dry air" and "moisture." "Bricks" or "clay" represent the material being dried, which will be considered to consist of "dry clay" and "moisture." English units (pound, degree Fahrenheit, and B.t.u.), customary terms in drying calculations, will be used.

Air quantities and air flow rates are expressed in terms of pounds of dry air because the weight of dry air entering equals the weight which leaves during the same time interval. Quantities of clay and rates of clay movement are expressed in terms of pounds of dry clay. The weight of iron in a drier car is in terms of dry clay carried by that car.

(4) Air for Moisture Carrying As the air flows through the drier its moisture content increases and its temperature decreases. It carries away moisture and supplies the heat required for evaporating the water. If the air entering the kiln and, therefore, the air entering the drier has a moisture content of M_{aa} and if the cool air leaving the drier has a moisture content of M_{ca}, the weight of water removed per pound of dry air is evidently $M_{ca} - M_{aa}$ pounds. Similarly, if the entrance and exit moisture contents of the clay are M_{cb} and M_{hb}, respectively, the weight of water removed per pound of dry clay will be $M_{cb} - M_{hb}$ pounds. Therefore, A_{mc}, the amount of air required for moisture carrying in terms of pounds of dry air per pound of dry clay, will be given by the equation

$$A_{mc} = \frac{M_{cb} - M_{hb}}{M_{ca} - M_{aa}} \tag{1}$$

(5) Air for Heat Supply For every pound of dry air which passes through the drier, the drying medium, air, which contains M_{aa} pounds moisture per pound dry air on entering, gives out a quantity of heat equal to $0.24\ (T_{ha} - T_{ca})\ (1 + 2\ M_{aa})$ B.t.u.'s where 0.24 is the specific heat of dry air, 0.48 or 2×0.24 is the specific heat of the moisture in the air.

For every pound of dry clay which passes through the drier, the heat used up is given by the expression

$$1.10\ [(M_{cb} - M_{hb})\ H + (T_{hb} - T_{cb})\ (0.11\ I + 0.25 + 1.00\ M_{hb})]$$

where 1.10 is a factor which allows for a heat loss of 10% of the net heat requirement; H is the number of B.t.u.'s required to convert 1 pound of water at T_{cb}, the entrance temperature of the bricks, into 1 pound of steam at T_{ca}.

The air required for heat supply, A_{hs}, expressed as pounds of dry air per pound of dry clay will then be given by the equation

$$A_{hs} = \frac{1.10\,[(M_{cb} - M_{hb})\,H + (T_{hb} - T_{cb})\,(0.11\,I + 0.25 + 1.00\,M_{hb})]}{0.24\,(T_{ha} - T_{ca})\,(1 + 2\,M_{ca})} \quad (2)$$

(6) Drier Equilibrium When a waste-heat drier of the type under consideration has been operated as a continuous drier for some time, a state of equilibrium is reached. The weight of moisture entering the drier during a given interval is then equal to the weight of moisture leaving the drier in the same interval and the energy input balances the energy output. When this state is reached, it is true that

$$A_{mc} = A_{hs} \quad (3)$$

where A_{mc} and A_{hs} are the amounts of air, expressed as pounds of dry air per pound of dry clay, required for moisture carrying and heat supply, respectively. A_{mc} and A_{hs} can be calculated by means of equations (1) and (2). Substitution in (3) gives the equation

$$\frac{M_{cb} - M_{hb}}{M_{ca} - M_{ha}} = \frac{1.10\,[(M_{cb} - M_{hb})\,H + (T_{hb} - T_{cb})\,(0.11\,I + 0.25 + 1.00\,M_{hb})]}{0.24\,(T_{ha} - T_{ca})\,(1 + 2\,M_{ca})} \quad (4)$$

The condition of equilibrium expressed by equation (3) or (4) must be satisfied before steady operation of a drier can be secured. If, in the design of a drier, the fan capacity, entrance air temperature, and the other quantities entering into equation (4) are given values which do not satisfy the equation, it does not follow that the drier will not operate efficiently[6] but it does follow that some of the quantities in equation (4) will have different values in practice from those specified in the design. In designing a drier, therefore, it is rational to specify values for the quantities in equation (4) which do satisfy the equation. These values will then be found to hold in practice at least approximately.

(7) Illustrative Example To illustrate the significance of equations (3) and (4), let us consider the design of a waste-heat drier when all the quantities in equation (4) except T_{ha}, the entrance temperature of the air, and T_{hb}, the exit temperature of the bricks, are fixed by plant conditions. Let us consider further that T_{hb} differs from T_{ha} by a constant amount. This is an example commonly taken when discussing drier design. In Fig. 2, the relations between A_{mc} and A_{hs} and T_{ha} for a typical case calculated from equations (1) and (2) are shown.

The value of A_{mc} is independent of T_{ha} as equation (1) contains no temperature term, the value of A_{hs} depends on T_{ha}, becoming smaller as T_{ha} increases, *i.e.*, less air is required to supply heat when it is entering the

[6] It is sometimes stated that a drier will operate most efficiently if $A_{mc} = A_{hs}$. This is not an accurate statement of the significance of this equation.

drier at a high temperature. The curves for A_{mc} and A_{hs} cross at the point P, and divide the chart into four areas labeled 1, 2, 3, and 4. If the air supply and entrance temperature are so chosen that their values when plotted give a point falling in area 1, the air supply will be more than sufficient for water-carrying but will give too little heat for evaporation; if in area 2, the air supply is more than sufficient for either water-carrying or heat supply; if in area 3, the air supply is insufficient for either water-carrying or heat supply; and if in area 4, the air supply is sufficient to supply heat for evaporation but insufficient to carry off the moisture. At the point P, the air supply is just sufficient to provide enough heat and water-carrying capacity. At this point, equations (3) and (4) are satisfied. The coördinates of point P can of course be obtained by direct substitution in equation (4).

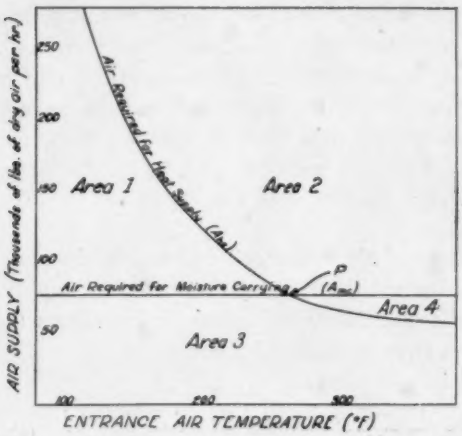

FIG. 2.—Illustrative example.

(8) Use of Equations Equation (4) contains 10 different quantities and at first sight its usefulness might appear to be very limited. All of these quantities, however, are not independent. The quantity H, the amount of heat required to convert one pound of water at T_{cb} into one pound of steam at T_{ca},[7] depends on T_{cb} and T_{ca} only. This dependence could be used to eliminate H from the equation, but usually it is easier to leave it in and use psychometric charts for finding H for particular values of the variables considered. The independent quantities, therefore, are nine in number. This number is greatly reduced in any particular drying calculation by assigning constant values to some of the quantities, *e.g.*, M_{cb}, M_{hb}, M_{ca}, I, T_{ca}, etc., or specifying relations between them, *e.g.*, between T_{ha} and T_{hb}. If the number of independent variables is reduced in this way to one, equation (4) can be used in determining its value; if two or more quantities remain independent, it can be used in finding the relationships which exist between them.

[7] In a drier, the water is actually evaporated, for the most part, at temperatures higher than T_{ea}; however, since the resulting vapor is cooled to T_{ea} before leaving the drier, no error is introduced by assuming that the evaporation takes place at this temperature. This follows from thermodynamic reasoning, and is not an approximation, as is sometimes stated.

(9) Generality and Limitations Equations (1) to (4) are concerned only with the heat and moisture balance of the drier. They do not include the conditions which must be satisfied before heat and moisture will be transferred in such a direction that the drier will operate. For example, the air surrounding a brick must be at a higher temperature than the brick before heat flow from the air to the brick will take place and the vapor pressure of the moisture in the air must be lower than the vapor pressure of the moisture in the brick before evaporation will occur.

The maximum drying rate of the clay and variations in outside temperature and barometric pressure are not considered. The relation of these conditions to drier design will be left for future discussion.

Apart from the limitations pointed out in the foregoing, equation (1) is quite general and applies to any drier in which air is used as a carrier for removing water, and equations (2), (3), and (4) are applicable to all continuous indirect-heated driers of the type described in the introduction.

III. Effect of Atmospheric Humidity

(10) Particular Conditions The first problem to be solved by the equations given in Section II was that of determining the effect of variations in the moisture content of air used for drying caused by changing weather conditions. Information regarding the feasibility of using silica gel for pre-drying the air was also desired. The procedure followed was that of assigning typical values to a number of the quantities occurring in equation (4) and finding the relations existing between the others. The important independent variable was M_{aa}, the weight of water per unit weight of dry air in the atmospheric air. An approximate idea of the variation which might be expected in M_{aa} during a year was obtained by summarizing the data reported by the New York Meteorological Observatory for the year 1927.[8]

TABLE II
DATA FOR EXAMPLE 1

Quantity*	Value	Remarks
M_{cb}	0.18 lb. water per lb. dry clay	18% moisture (dry basis)
M_{hb}	0.000 lb. water per lb. dry clay	Complete drying
M_{ca}	0.034 lb. water per lb. dry air	94% R. H., 95°F
M_{aa}	Variable	Dependent on weather conditions
T_{hb}	$T_{ha} - 30$°F	Likely difference
T_{cb}	55°F	Average New York temperature for 1927
T_{fa}	$T_{ha} + 50$°F	Likely difference
T_{ha}	Variable	
T_{ca}	95°F	Common practice
H	1080 B.t.u.	Calculated from T_{cb} and T_{ca}
I	0.20	500 bricks on a 500-lb. car. 5 lbs. dry clay per brick

* Significance of symbols given in Table I.

[8] Report of the New York Meteorological Observatory of the Department of Parks, Central Park, New York City, for the year 1927.

In Table II the different quantities in equation (4) are listed along with the values which were assigned to those considered constant in the calculations, or dependent on other quantities.

An examination of Table II will show that only T_{ha} and M_{aa} were allowed to vary independently.

(11) Figure 3 The Meteorological tables showed that during 1927 in New York the value of M_{aa} varied from nearly zero to 0.017 lb. moisture per lb. of dry air. A series of values of M_{aa} ranging

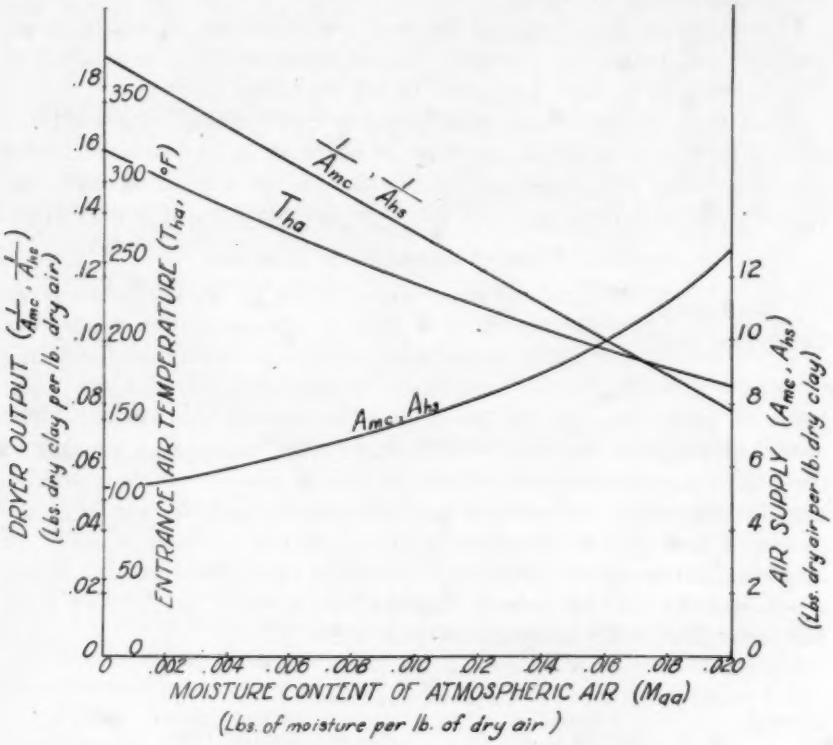

FIG. 3.—Effect of atmospheric humidity on drier operation.

from zero to 0.20 were tabulated and by means of equation (1) corresponding values of A_{mc} were calculated using the data given in Table II and assuming that no moisture was absorbed by the ware in the kilns. The values of A_{mc} were then used with equation (4) to calculate values of T_{ha}. The results of these calculations are shown graphically in Fig. 3, where values of M_{aa} are plotted as abscissas and values of A_{mc}, $1/A_{mc}$, and T_{ha} as ordinates. It will be observed that as M_{aa} increases, $1/A_{mc}$ decreases, A_{mc} increases, and T_{ha} decreases. In other words, as the moisture con-

tent of the atmospheric air increases, a drier operating under the prescribed conditions will dry less clay per pound of dry air used, will use more air to dry a pound of clay, and will operate with lower entrance air temperatures.

(12) Figure 4 In order to show the relation between atmospheric humidity conditions and drier operation more clearly, the graph shown in Fig. 4 was prepared. A drier, which with a fan capacity of 22,000 cu. ft. per minute would have an output of 50,000

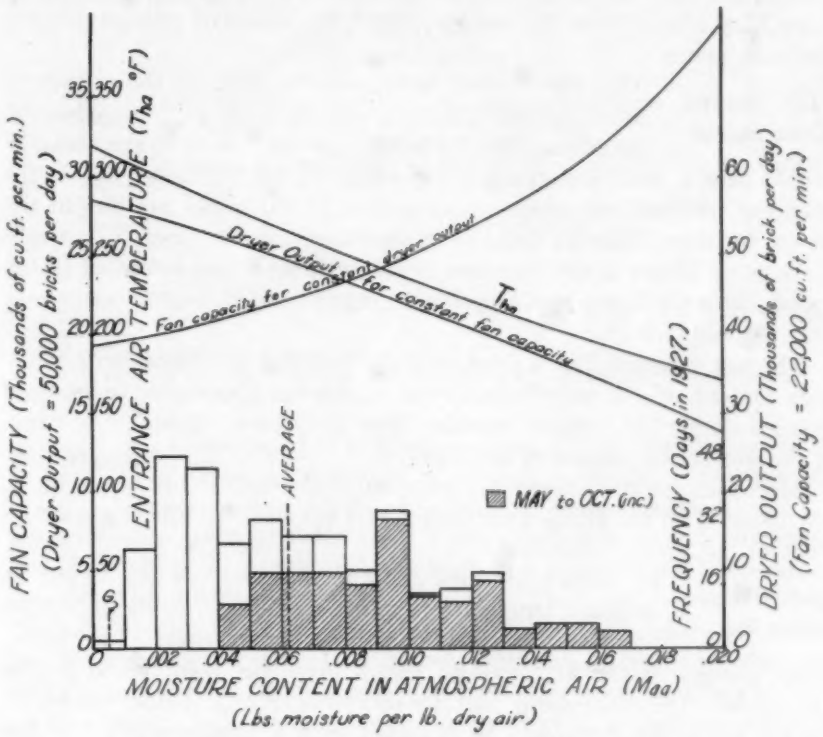
FAN CAPACITY (Thousands of cu. ft. per min.)
(Dryer Output = 50,000 bricks per day)
ENTRANCE AIR TEMPERATURE (T_{ha} °F)
DRYER OUTPUT (Thousands of brick per day)
(Fan Capacity = 22,000 cu. ft. per min.)
FREQUENCY (Days in 1927.)
Dryer Output for constant fan capacity
Fan capacity for constant dryer output
T_{ha}
AVERAGE
MAY to OCT. (inc.)
MOISTURE CONTENT IN ATMOSPHERIC AIR (M_{aa})
(Lbs. moisture per lb. dry air)

FIG. 4.—Effect of atmospheric humidity on drier operation.

bricks per day under average weather conditions ($M_{aa} = 0.0062$) was taken as an example and the data shown in Fig. 3 converted to practical units. Values of M_{aa} were plotted as abscissas and the fan capacity required for a daily output of 50,000 bricks, the output corresponding to a constant fan capacity of 22,000 cu. ft. per minute, and the entrance air temperature, T_{ha}, were plotted as ordinates. Again it is evident that, as the moisture content of the atmospheric air increases, the fan capacity required for a constant output increases rapidly, the output obtained with

a constant fan capacity decreases rapidly, and the entrance air temperature, T_{ha}, is lowered.

In order to show the variations in M_{aa} which may be expected during a year, a histogram[9] showing the number of days during 1927 in New York for which the average value of M_{aa} fell between given limits was erected on the M_{aa} scale. A scale of days is given at the right of Fig. 4. Thus, for four days in 1927, the daily mean values of M_{aa} were between 0.016 and 0.017, etc. The average daily mean value for M_{aa} for the year was 0.0062. The shaded part of the histogram forms a histogram for the period from May 1 to October 31, inclusive, 1927, the period of greatest activity for some plants.

(13) General Conclusions The curves and histograms in Fig. 4 show that a drier operating with a constant fan capacity designed for drying 50,000 bricks per day in average weather would have a possible output of only about 32,000 bricks per day in the dampest weather and a possible output of 54,000 bricks per day in the driest weather. The air entrance temperature of the drier, T_{ha}, would have to be higher in dry weather, probably higher than indicated in the graph, since the driest days occurred during the coldest weather when heat losses would be high.

The histograms in Fig. 4 show that the variation in atmospheric moisture content, M_{aa}, is quite large during an interval of one year and is large enough during the summer months, May to October, inclusive, to cause a variation in the output of the drier.

More uniform and economical operation of the drier would be obtained, therefore, (1) if the air used for drying were pre-dried or (2) if its moisture content, M_{aa}, were controlled.

(14) Use of Silica Gel By means of silica gel, the moisture content of air at ordinary temperatures can be reduced readily to 0.0005 pound water per pound dry air and lower. This value, when plotted on the M_{aa} scale in Fig. 4, gives the point marked G in the figure. The chart shows that, for this value of M_{aa}, a drier output of 50,000 bricks per day could be obtained with a comparatively low fan capacity (about 20,000 cu. ft. per minute), under the conditions assumed when preparing the chart. The cost, however, of drying 20,000 cu. ft. of air per minute with silica gel might be prohibitive. On the other hand, it might prove economical to pre-dry *part* of the air by means of silica gel on particularly damp days, regenerating the silica gel on the intervening dry days. In this way the occasional falling off in capacity caused by the very damp days, see Fig. 4, might be lessened by drying about 5000 cu. ft. of air per minute.

[9] The construction and use of histograms have been described in a previous paper, *Jour. Amer. Ceram. Soc.*, **10** [3], 133–47 (1927).

IV. Importance of Air Outlet Temperature

(15) Particular Conditions The second problem to be solved by the equations was that of determining the relation between drier output and outlet air temperature for a typical waste-heat drier. In this case, the important independent variable was T_{ca}, the temperature of the cool air leaving the drier through the stack. The other quantities in equation (4) were treated as shown in Table III. The other essentially variable quantity was T_{ha}, the temperature of the hot air entering the drier.

TABLE III

DATA FOR EXAMPLE 2

Quantity*	Value	Remarks
M_{cb}	0.18 lb. water per lb. dry clay	18% moisture (dry basis)
M_{hb}	0.00 lb. water per lb. dry clay	Complete drying
M_{ca}	Dependent on T_{ca}†	95% R. H.
M_{ha}	0.0062 lb. water per lb. dry clay	Average daily mean for New York, 1927
T_{hb}	$T_{ha} - 30°F$	Common difference
T_{cb}	55°F	Average daily mean for New York, 1927
T_{fa}	$T_{ha} + 50°F$	Likely difference
T_{ha}	Variable	
T_{ca}	Variable	
H	Dependent on T_{ca}	$T_{cb} = 55°F$
I	0.20	500 bricks, 500-lb. car. 5 lbs. dry clay per brick

* Significance of symbols given in Table I.

† 95% relative humidity was specified for outlet air. This would ordinarily prevent condensation on the bricks.

(16) Figure 5 Values of T_{ca} ranging from 70 to 150°F by 10°F steps were taken. For each value of T_{ca}, values of T_{ha}, A_{mc}, $1/A_{mc}$, etc., were calculated by means of equations (2), (3), and (4) using the data given in Table III. These values were used in preparing Fig. 5, in which air supply, drier output, and entrance air temperature are plotted against the outlet air temperature. The figure shows that, when the outlet air temperature is raised under the conditions specified in Table III, the air supply required for constant output decreases rapidly, the drier output for constant air supply increases very quickly, and the entrance air temperature required to maintain an equilibrium of moisture-carrying and heat-supply requirements increases at first slowly and then rapidly, approaching infinity for $T_{ca} = 142°F$.[10] Therefore, although an increase in drier output could ordinarily be obtained by raising the outlet air temperature, yet there is a decided limit to the amount which it could be raised in practice.

[10] For T_{ca} greater than 142°F, negative values of T_{ca} were obtained. These correspond to hypothetical drier conditions in which the heat required for evaporating water and heating the air to T_{ca} is obtained from the cooling bricks. Such conditions would require evaporation of water from clay to air which is already supersaturated and the passage of heat from a cooler to a hotter body, phenomena which are contrary to experience. See Section II, especially Paragraph 9.

(17) Figure 6 Figure 6 was prepared by converting the data shown in Fig. 5 to more practical units, it being further assumed that the fan temperature was 50°F higher than the drier entrance temperature. A typical drier having a fan capacity of 22,000 cu. ft. per minute and an output of 50,000 bricks per day when the drier outlet temperature was 95°F was considered. Curves were drawn showing the de-

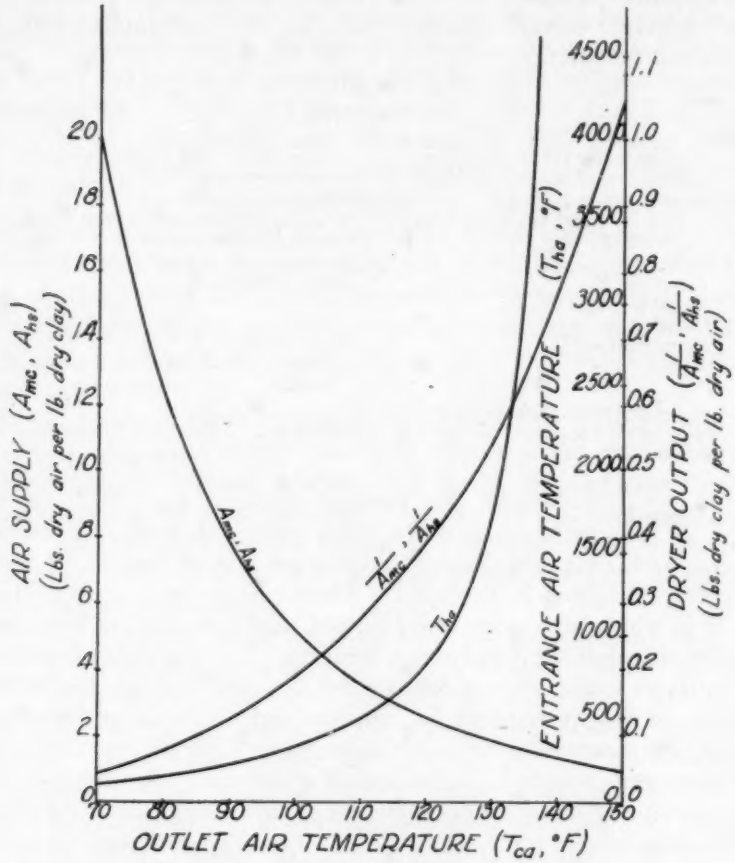
AIR SUPPLY (A_{mc}, A_{hs})
(Lbs. dry air per lb. dry clay)
ENTRANCE AIR TEMPERATURE (T_{ha}, °F)
DRYER OUTPUT ($\frac{1}{A_{mc}}$, $\frac{1}{A_{hs}}$)
(Lbs. dry clay per lb. dry air)
$A_{mc}:A_{hs}$
$\frac{1}{A_{mc}}, \frac{1}{A_{hs}}$
T_{ha}
OUTLET AIR TEMPERATURE (T_{ca}, °F)

FIG. 5.—Relation between air outlet temperature and drier operation.

pendence upon drier outlet temperature of (1) drier output at a fan capacity of 22,000 cu. ft. per minute, (2) fan capacity for a fixed drier output of 50,000 bricks per day, and (3) entrance air temperature. An examination of the curves shows that, as the drier outlet temperature is raised, the drier output at constant fan capacity increases rapidly until T_{ca} is equal to about 118°F, after which it decreases rapidly; the fan capacity for a constant drier out-

put decreases and then increases rapidly; and the entrance air temperature, T_{ha}, increases slowly and then rapidly, reaching practically prohibitive values for values of T_{ca} greater than about 120°F.

(18) Conclusions The information given in Figs. 5 and 6 shows that, for a drier operating under the conditions stated in

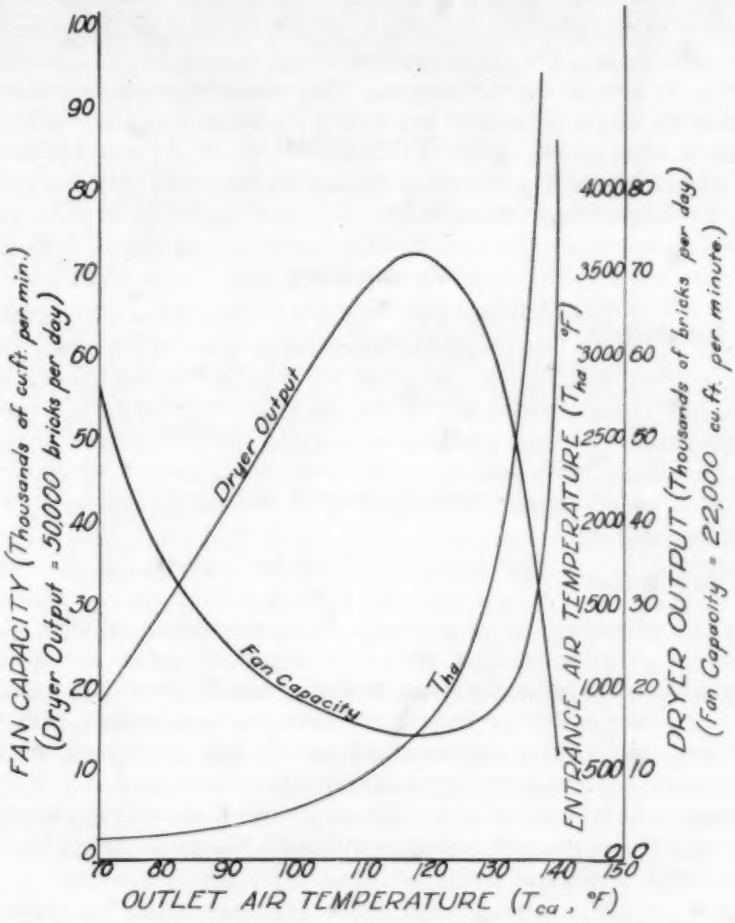

FIG. 6.—Relation between air outlet temperature and drier operation.

Table III and at a fairly low air outlet temperature, an increase in the outlet air temperature enables production to be increased. As the drier outlet temperature is increased, however, a point is reached beyond which loss in production and abnormally high entrance temperatures are encountered. For the example discussed this critical point is between 115°F and 120°F.

(19) Possible Changes in Design In the foregoing example it was shown that, for the drier considered, an increase in drier outlet temperature above about 120°F was not practical. It might be possible, however, to change the design of the drier in such a way that this limitation would not be so severe. This might be done by using direct as well as indirect heating or by changing the drier operation so that the heat brought in by the entrance air would be used more completely. The latter method would depend on the recovery of some of the heat in the outlet gases. This might be accomplished by increasing the length of the drier and cooling the air in flues before it went to the stack, since cooling the air in contact with the bricks would cause condensation. The heat given out by the cooling air would then be radiated from the flues to the incoming bricks.

V. Summary

(20) Conclusions A study of the figures led to the following conclusions regarding the operation of a waste-heat drier under the conditions described in the paper: (1) that the production of a drier depends to a considerable extent on the moisture content of the atmospheric air, (2) that drier output could be increased by pre-drying the air, and (3) that the control of the moisture content of the entrance air by pre-drying part of it would permit steadier production but might not be economically possible.

(21) Suggestions The pre-drying of air for a waste-heat drier could be accomplished by means of silica gel. Although complete pre-drying would probably be uneconomical in view of the volume of air to be handled, pre-drying of part of the air during damp weather to avoid irregularity in output might prove feasible. The moisture-carrying power of the air leaving the drier increases rapidly with temperature. In a typical waste-heat drier of the type considered, however, the temperature of the outlet gases could not be raised above 120°F unless abnormally high entrance air temperatures were used or the construction of the drier were changed. One such possible change in design has been discussed in the paper.

DRYING HEAVY CLAY PRODUCTS IN A PROGRESSIVE DRIER USING RADIATED HEAT AND MECHANICAL CIRCULATION[1]

By H. R. Straight

ABSTRACT

The principles which should be followed for the safe drying of clay products are discussed. These are as follows: (1) direction of air circulation, (2) rate of air circulation, (3) humidity, (4) the use of clear air, (5) temperature of air in drier. A pallet system is proposed as an ideal manner of arrangement in the drier for drying brick, hollow tile or drain tile, and similar heavy clay products.

Introduction

The principles which should be followed for the safe drying of any clay products have in recent years been clearly established and have been found to be identically the same as those involved in the safe drying of lumber, leather, paper, soap, and similar porous bodies. These principles will be discussed in the order of importance as they apply to the drying of heavy clay ware. Only a few definite figures will be quoted on account of the variation of clays, of masses of units, and general conditions which might lead to serious losses if taken too literally without due consideration being taken of all the factors involved.

Direction of Circulation

It is a well-known physical law that air in cooling falls because it becomes heavier and upon being heated rises because it becomes lighter.

Air that is moved upward, when being heated, moves more uniformly across any flue section with fewer eddy currents being set up than are set up if the direction is reversed.

Air which is being cooled should be moved downward if the uniform flow is to be expected.

A well-known example of this last law with which clayworkers are familiar, is encountered in the updraft kilns. If a cold spot once forms in an updraft kiln, due to an uneven setting, it is impossible to eliminate it by regulation of the firing. The reason is, that the gases in rising tend to flow where cooled the least, for the warmer spots absorb less heat than the cooler spots and the result is that the cold spots are exaggerated. In a downdraft kiln the reverse is true, that is, the cold spots are to a great degree self-eliminating because of the greater rapidity with which the heating gases tend to fall through the cooler regions.

The ware in the drier absorbs a much greater amount of heat for its range of temperature than the ware in the kilns and the direction of

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received December 20, 1928.

circulation is of prime importance in this heat transfer. The principle that the circulation must be downward through the ware in drying, is a fact not truly subject to question.

Rate of Circulation

The rate of circulation has been determined by experiment in the heavy clay industry for various kinds of ware, as well as in the other industries, and has been found to be closely tied to the porosity of the body being dried. If the body is very porous, the moisture will travel rapidly to the surface by capillarity or internal vaporization from which surface the moisture or moisture vapor will be constantly removed by the wiping action of the circulating air. When the rate of travel of the moisture is rapid in the body, the moisture may be removed rapidly without "case hardening" or surface drying, faster than interior drying. If "case hardening" occurs, the body near the surface tends to lose its capillarity and strains are set up that cause drier losses, which may be evident before firing but which often do not show up until after the ware has been drawn from the kilns.

Experiments in a special laboratory drier have determined that it is impossible to secure uniform drying with any degree of rapidity without the aid of mechanical means for recirculating the drying air many times over the ware before the air is finally discharged with its quota of moisture. The amount of circulation that even tender clays will stand, where the direction of circulation is correct and other conditions are properly regulated, is truly surprising.

Humidity

Consideration must be given to a number of factors when the degree of humidity used in a drier is to be determined.

The color of the finished ware is influenced by the degree of humidity. A low humidity tends to give greater brilliancy but too low a humidity will cause "case hardening," the same as too rapid a circulation. It is also well known to experienced clayworkers, that too low a humidity will cause uneven drying of the units. This is due chiefly to the greater absorption of the air in more intimate contact with the ware where it first impinges on the ware. The contact then is lessened as the air progresses along the sides of the ware because the friction of the air along the sides of the ware has a tendency to throw the air outward. If too low a humidity is used, the drying is harder to regulate within safe limits.

On the other hand, the degree of saturation of the drying air greatly affects the amount of radiation per square foot of radiating surface for each degree of temperature differential. Trinks, of Carnegie Institute,

gives data in the appendix of his second edition of Industrial Furnaces, which shows how greatly this factor influences radiation. Dry air has a very much lower heat-absorbing and carrying capacity than air with a mixture of moisture vapor.

Blistering is often greatly exaggerated where the moisture content of the air is too high, because the body temperature of the ware, when first entering the drier, is sometimes below the dew point of the air and results in actual absorption of moisture by the ware. The resulting pasty condition tends to allow any air confined in the body of the ware to expand and blistering is thereby greatly exaggerated.

Exhaustive tests, made at the Bureau of Standards by the American Face Brick Association, showed that in most shales a 50% humidity is an all-round safe point to start from to determine what is best for any individual clay.

Air Conditions

In any commercial drier, the use of clear air is of great importance for the reason that the resulting color is better where no sulphur gases are present. The deterioration of drying equipment is largely eliminated and the working conditions are greatly improved. In order to use the waste heat from firing or cooling kilns and still have air that is free from sulphur gases, it is evident that radiated heat is necessary. In the past, radiating surfaces have been installed below the drying ware with the result that the heated air travels chiefly upward through the ware and in falling, after it is cooled, sets up eddy currents and results in uneven drying. Such an arrangement does not lend itself to mechanical circulation. In a drier recently built, a series of heating pipes were installed in compartments between a series of sections containing four car drier tracks. The air is circulated upward over the radiating pipes by airplane type propeller fans operating in the top of the pipe compartment and the air is discharged vertically upward against the drier ceiling under which it is spread to each side and pulled downward through the ware on the drier cars.

The air is induced downward through the ware to replace air that is being taken into the heating pipe compartments. It is taken in below the tracks and is in turn circulated past the pipes and then upward again through the fans. The fans used are all of the same capacity but placed increasingly closer together in the top of the pipe compartments as the ware discharge end of the drier is approached.

All air for carrying the moisture from the ware is taken out at the ware receiving end of the drier, through ports, into a general flue which conducts the gases and cooling air from the kilns to the exhaust fan. This exhaust fan furnishes draft to the kilns, bringing in the kiln gases through the

heating pipe. Since the air for carrying the moisture from the drier is comparatively small in volume, compared with the volume of air handled by each circulating fan, it is evident that the air is very largely recirculated by each fan and the path of the drying air is therefore in the form of very flat spirals upward on the sides where it passes around the heating pipes and through the fans and downward on the sides where it passes through the ware.

Most clays will stand a rapid speeding up of the circulating air over the ware after shrinkage is largely eliminated and most clays have their drier shrinkage completed when two-thirds to three-quarters of the moisture has been taken out.[2] Since it is most convenient to have the circulating fans and their motor drive of a uniform size, it is therefore simpler to space the fans closer together as the rate of circulation per unit of surface of ware being dried can safely be increaseed. Rates of circulation as high as one hundred feet per minute will not damage fairly tender clays after reaching the leather hard stage if the humidity is not too low, the temperature too high, and the direction of the circulation is correct.

Temperature

The temperature of the air in the drier, where proper mechanical circulation is used, may be surprisingly low. When a comparatively low temperature is used with such circulation, tender ware will be easily dried with proper regulation of humidty and direction of circulation.

By recirculating the air past the radiation surface, it is easily seen that a very great advantage is secured because the air temperature, where drying is completed, need not be high, for heat is constantly being supplied to make up for that being absorbed by the ware as the air progresses toward the exhaust ports. A saving is therefore made in heat, which would be lost if the ware is taken from the drier while hot. In most cases the heat in the ware when pulled while hot from the drier is allowed to dissipate in a cooling storage section outside the drier.

Any clay, no matter how harsh a drying treatment it will stand, is improved by careful, uniform drying at a fairly low temperature. In this way internal drying strains are at a minimum. It must be a fact that the rending action tending to tear the particles apart within the drying body of the unit, caused by too rapid drying, will surely show up in crushing, freezing, absorption, or transverse tests of the units.

Progressive Movement

In order that uniform results may be obtained, practical experiments have demonstrated beyond a doubt the advisability of a process for

[2] It has been found that in many clays there is an actual expansion with the removal of the last of the moisture.

drying as near continuous as possible. The ideal condition of course would be twenty-four hours' operation of manufacturing and setting. The best obtainable with ordinary plant operation may be greatly helped by regulation which will automatically control the humidity and temperature to take care of drying out that occurs during the night when no ware is being handled through the drier. In this way moisture will still be available from the ware manufactured the day before for maintaining the proper humidity for the run the next morning.

With sufficient mechanical circulation and other conditions of temperature and humidity properly regulated, it is not difficult to dry ware made early in the morning sufficient to be set before evening.

Handling of Ware

The ideal manner of arrangement in the drier for drying brick, hollow tile, or drain tile and similar heavy clay products, is a pallet system. In such a system the ware could be set mechanically from the machine with a uniformity not obtainable by hand. The pallets could be moved through the drier mechanically and the ware as discharged from the drier could be set directly onto tunnel kiln cars handled on a transfer as they are being loaded. The circulation in such a drier with the units one tier deep only, could be more positively regulated in its direction and the drying would take place more uniformly. The labor saving in such a drier would be remarkable and the uniform setting and other savings effected would pay splendid returns on the extra cost of machinery equipment, power, and upkeep.[3]

Conclusion

General progress has been somewhat slow along the line of these improvements but the results obtained during the past year at the new plant in which the writer is interested, have proved the value of the statements made in the foregoing pages. Automatic regulation has not yet been obtained but equipment is being installed with which it is hoped proper temperature and humidity regulation will be secured. The drier was built with this plan in view.

The final strength, color brilliancy, and grade is greatly dependent on the drying process, and production is greatly governed by the quantity of properly dried ware.

As in all lines, the clay products industry is dealing with the problem of fighting for its very existence against competing materials. Only by serious study of this problem can this industry survive.

ADEL CLAY PRODUCTS COMPANY
ADEL, IOWA

[3] It is one of the ambitions of the writer to see this plan worked out.

VITREOUS ENAMEL AND ITS DEFECTS[1]

By A. Malinovszky

ABSTRACT

Causes for various defects in enameled cast iron ware are traced in the enamel ground coat and iron. Photographs show the iron defects.

Introduction

There is not much published information on the question of control of the combined defects in vitreous enamel. The purpose of this paper is to discuss some characteristics of ground coat, enamel, and cast iron.

The Ground Coat

Ground coat should be composed only of those materials which will go completely into the glass solution, such as quartz, borax, feldspar, and cobalt and nickel oxides; some formulas even contain cryolite, fluorspar,

Fig. 1.

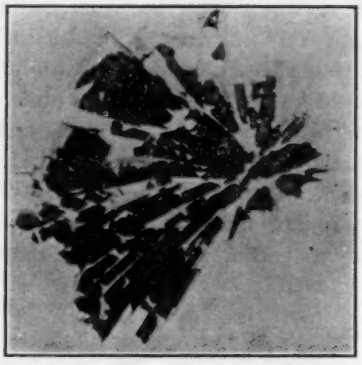

Fig. 2.

The shattered enamel is shown after a series of hard blows on the back of the casting.

bone ash, and zirconium and manganese. No easily reducible metallic oxides, such as zinc, tin, or antimony, etc., should be present.

The ground coat should be resistant to the gases of carbon, and should prevent their passage from the iron to the enamel. It should form a neutral layer between the iron and enamel, having a strong grip on the cast iron and being a firm foundation for the enamel.

The ground coat should so adhere by fusion to the metal that it will not lift or chip when shifting or firing the enamel.

The oldest ground-coat frit for cast iron given by Vogelgesang,[2] con-

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.) Received December 10, 1928.

[2] Moritz Vogelgesang, Die Eisen, Emailleurkunst, 1851.

tained quartz 60 to 62.50, borax 40 to 37.50. Another formula contained quartz 61, borax 33, and lead carbonate 6; also quartz 35, feldspar 35, and borax 30. These compositions are in use today.

A ground coat which is refractory and has a long range can be applied very thin on the iron, whereas a soft ground coat with a short range must be applied somewhat heavier.

When a ground coat is too thin and soft on firing, it is easily overfired. The enamel would then attack the metal, causing blisters and the tin oxide, antimony, lead, and zinc in the enamel would be reduced to their metallic states, forming black specks.

Thick ground coat must be avoided as it may entrap bubbles of air, moisture, or gases during firing. These gases will rise through the enamel and form blisters.

Many authors have discussed the rôle of small amounts (0.5% or less) of cobalt oxide or nickel oxide in producing adhesion between the ground

FIG. 3.

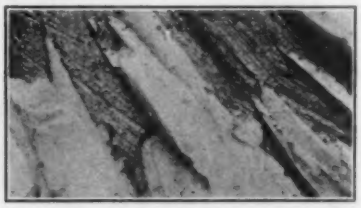

FIG. 4.

Showing the parting of the enamel after the tub was broken with a sledge hammer. The adhering quality of the ground coat and enamel to the iron is shown in Figs. 1, 2, 3, and 4.

coat and the metal. The latest theories given by Froelich[3] are magnetic, galvanic, and electrolytic coatings by cobalt, nickel, and manganese. That cobalt, nickel, as well as other oxides used in a ground coat should give an action similar to that in electroplating, is a theory only, which still has to be proved.

L. Vielhaber, who showed the adhesive qualities by microphotographs (Die Zusammensetzung der Emailleglasuren) of cobalt, nickel, manganese, zircon, iron, titanium, tin, copper, chromium, uranium, and arsenic oxides in ground coat, has come to the conclusion that cobalt and nickel oxides give the best resistance to shocks, blows, and temperature changes, and also better adhesion. Coefficient of expansion, compression, and tensile strength, are not as important in ground coats as they are in the enamel, because the ground coat is applied on the cast iron as a very thin coat.

[3] Praktisch Email Wissenschaft, p. 71.

Preparation of the Iron Surface

Sometimes concentric, radial, parallel, or curved lines are to be seen on the surface of the enamel. These lines are often mistaken for crazes or lifts. Changing the coefficient of expansion of the enamel will not correct the trouble. These fine hair lines are caused by thick spots in the castings, especially where lugs, ribs, or braces are present. The ground coat does not fuse properly at these thick spots and the results are a poor bond between the casting and enamel.

The importance of having the surface of the cast iron clean before the ground coat is applied is well known. Insufficient sandblasting and

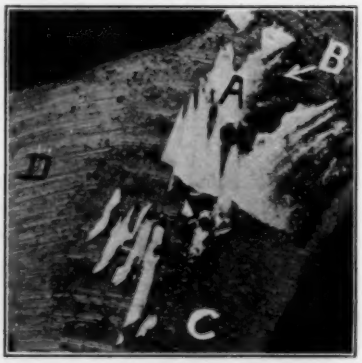

FIG. 5.—"A" represents the enamels, "B" the ground coat, "C" the unground surface of the cast iron, and "D" the surface ground with the emery wheel. It is shown that surface "D" has no ground coat, but the ground coats of "B" and "C" are well represented.

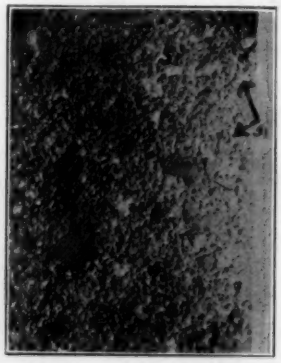

FIG. 6.—Shows the silica (molding sand) fused into the surface of the casting; the sections with the lines are the cast iron, which shows the alternate spots where the emery wheel has touched the iron at the high places of the casting, leaving behind the sand.

cleaning will cause blisters, chipping, and popping off of the enamel. Molding sand and scales left on the iron cause gases to be given off and to form blisters. (See Figs. 6 and 7.) Too much grinding, however, should be avoided. The open surface of the casting should not be destroyed or the casting burned producing hard spots.

After cleaning and thoroughly sandblasting a burning (No. 1) and a $^1/_{16}$-inch shaving machined off the surface (No. 2) the analyses in Table I were obtained.

The greatest difference between the surface and interior of the cast iron is in the combined carbon and silicon and is less in total carbon and graphitic carbon and still less in P and S.

TABLE I

	I	II
Total carbon	2.972	2.890
Graphitic carbon	2.099	2.154
Combined carbon	0.873	0.736
Silicon	2.702	2.842
Manganese	0.600	0.600
Phosphorus	0.715	0.706
Sulphur	0.104	0.081

A surface shown in Fig. 6 must be thoroughly sandblasted, then filed and rubbed with Carborundum stones until every part of the surface is smooth and free from sand.

The Enamel

The two most effective factors other than composition influencing the fusibility of the enamel batch are fineness of grains and homogeneous mixing. Each material must be uniformly distributed throughout the batch to effect uniform fusion.

The velocity of draft and temperature should be under control, checked by draft gage and pyrometers. If smelters are properly equipped, properly operated, and high flame velocity avoided, the smelting losses are reduced and more uniform colors of the batches obtained.

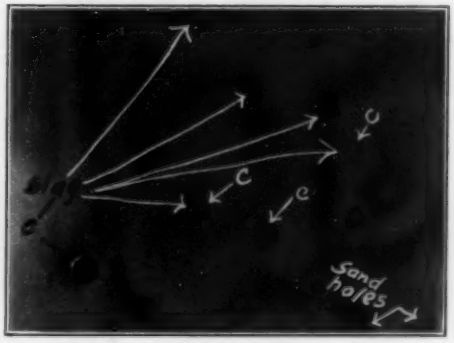

FIG. 7.—"C" represents the slag in the casting mixed with free silica (sand grains). Some of these slag and sand holes are deep and will spread in the inside.

Smelting at too low a temperature will cause discoloration and numerous other troubles such as poor gloss, pinholes, and blisters. Enamels which are not sufficiently smelted will blister (glass-eye) and pinhole, over the whole casting. This is especially true with enamels high in fluorides, due to the volatile silicon fluoride. A greater danger for such enamels is that they are susceptible to attack by chemicals, fruit acids, and the atmosphere.

It is astonishing how the smelted batch of an enamel deviates from the calculated oxide content of the enamel batch.

Table II shows: (1) the calculated oxides from materials used in the enamel batch; (2) and (3) analyses of two batches of frits intended to be the same; and (4) the analyses of the collected material from flues and stack of smelter.

TABLE II

ANALYSES OF FRITS

	Calculated analysis of raw batch	Smelted batch material collected at base of smelter stack		
		I	II	III
SiO_2	26.87	28.70	29.09	16.16
Al_2O_3	8.20	8.85	9.02	6.86
Fe_2O_3		0.27	0.29	
CaO	4.90	3.29	3.77	7.85
MgO	0.15	0.18	0.29	0.31
BaO	9.20	9.22	9.36	1.19
ZnO	10.60	11.35	11.19	2.95
PbO	1.48	1.59	1.32	3.15
B_2O_3	12.18	11.34	10.69	14.84
K_2O	5.35	5.62	5.46	2.82
Na_2O	10.22	8.57	8.24	8.59
Sb_2O_5	9.20	8.92	9.12	7.74
F	4.46	2.38	2.14	27.69
	102.81	100.30	99.98	100.15

Suitable Iron Composition and Structure

The carbon, silicon, manganese, sulphur, and phosphorus contents are the prime factors determining the type of cast iron suitable for en-

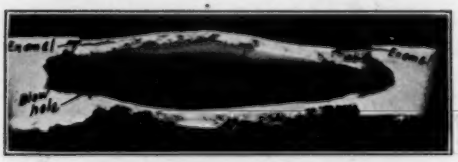

FIG. 8.

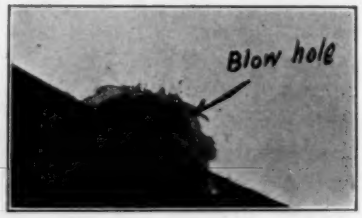

FIG. 9.

Represent blow holes. Notice the enamel on the curve and the space between the enamel and iron in some places.

ameling purposes and in the control of the physical properties of the cast iron. Uniformity in the composition and constitution of the cast iron is essential. Variations in the constituents or composition of the cast iron will cause variations in the coefficient of expansion and other physical properties of the metal.

L. Vielhaber[4] shows that 0.01 of sulphur increases the coefficient of expansion of the cast iron 55 points, whereas an increase of silicon by 0.1 decreases the coefficient of expansion 55 points. If these variations are continuous, the result will be constant chipping and crazing.

The surface of the casting must be smooth, free from holes, slag, sand, and other defects to produce first-class enameled ware.

Blisters may be caused by dirty iron, due to rust in the pores of the metal

[4] Die Konstruktion der Emailleversätze on p. 50, Band 2.

or to minute particles of slag incorporated in the surface layers during casting; also by molding sand fused into the surface layer of the casting, as shown in Fig. 6.

During the past several years numerous papers have been written discussing blisters and pinholes. Most of these papers have dealt with the subject of carbon in the iron. Hansen,[5] Harrison,[6] and others found that blistering of the enamel was eliminated by machining the surface of the casting. A good molding sand and good sandblasting will eliminate

FIG. 10.

FIG. 11.

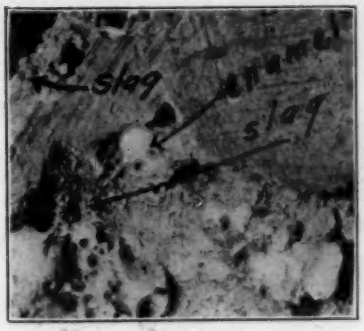

FIG. 12.

FIGS. 10, 11, and 12.—Represent slag holes. Fig. 11 is a typical slag hole. Fig. 12 is the same as Fig. 11, enlarged.

to a great extent the common defects of blistering and pinholing. When the molding sand is too fine or has too low a fusing point it will fuse to the metal and must be scraped, filed, or ground off. In cases like this a very high pressure sandblasting with sharp sand is required.

[5] J. C. Hansen, "Practical Aids to Wet Process Cast-Iron Enameling," *Bull. Amer. Ceram. Soc.*, **7** [5], 122 (1928).

[6] W. N. Harrison, C. M. Saeger, Jr., and A. I. Krynitsky, *Jour. Amer. Ceram. Soc.*, **11** [8], 595–608 (1928).

Sometimes, by picking with a fine-pointed tool or knife, it is found that it will break through the shell, leaving holes, some of which increase in cross-section as one penetrates further into the metal. When the hot metal comes in contact with the mold the sand, being high in flux content, fuses and gas is given off. If this gas cannot escape, it will be retained and penetrate into the metal. A surface containing fused sand and retained gases will cause pinholing and blistering.

FIG. 13.—Scab casting.

Very often small beadlike holes can be seen on the surface of the casting, and before sand-blasting numerous black spots show along the flow of metal filled with slag (Fig. 7). These conditions invariably cause blistering and pinholing of the enamel. Slag holes or pockets are originated by the sand in the mold.

The boiling of iron in the mold is caused by excess moisture in the sand. This in turn will give scaly castings, cold shots, scabs, and rough spots.

When the sand is too coarse a rough surface will result either from the coarseness of the sand or from the sand being washed away.

FIG. 14.

Sand too dry or too weak in bond will cause rough or spongy surfaces, runouts, dropouts, and runners.

Water, present even in small quantities, will cause blows and scales and cold shots.

Sand, if too strong, will cause blows, scabs, cold shots, and misruns and hard ramming may create cold shot castings due to inability of the gas to escape.

Slag Holes or Slag Pockets When iron is melted, the carbon, sulphur, phosphorus, etc., enter the fusion but, not being soluble in the solid metal, they have a tendency to separate out. As the metal solidifies, it begins at the outside, rejecting its impurities, the latter being taken up by the molten iron in the interior. That portion of the casting which is the thickest and solidifies last, will contain the most carbon, sulphur, and phosphorus. This makes the "hot spots."

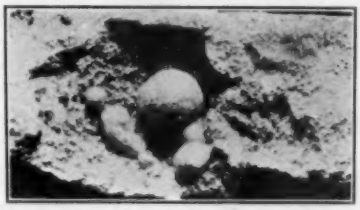

FIG. 15.—Shows the imbedded iron globules in the cast iron.

The enamel on such areas will break out, or spider craze, or it may pop off entirely.

Blistering is formed by dirt being worked away from the mold face when pouring the metal, causing projecting pockets. These in turn form blisters after the enamel has been applied and fused to the surface of the casting. Figures 10, 11, and 12 represent typical slag pockets. Figure 12 is same as Fig. 11, enlarged.

Cold Shots Cold shots are globules of solidified drops of hot metal scattered and carried along by the rush of the falling stream, which are trapped in the mold and not fused by the surrounding metal.

These globules are harder than the remainder of the casting, and after sandblasting and grinding, a spot the shape of a ring can be seen imbedded in the casting. If these globules are very large or very small the enamel will pop off (see Fig. 14).

Scabs Scabs are imperfections in the surface of a casting due to the breaking or washing away of portions of the mold (sand) by the stream of molten iron.

Faulty venting is usually caused by green sand or ramming too hard, or possibly too much moisture in the sand, retarding the escape of air and mold gases.

(See Fig. 13.) "A" is a piece removed from "B;" the piece which had been forced away by cooling showed first a craze.

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Acknowledgment The writer wishes to thank G. B. Schneider, General Manager, Washington Iron Works, for the permission to conduct this work; also T. S. Curtis, of the Vitrefrax Corporation, for the photographs.

PHYSICAL TESTS FOR VITREOUS ENAMELS. I[1]

Determining Physical Properties of Vitreous Enamels

By C. J. Kinzie[2]

ABSTRACT

Methods and apparatus for determining certain physical properties of vitreous enamels are described. These properties are as follows: (1) resistance to thermal shock of vitreous enamels applied to flat surfaces, (2) resistance to mechanical impact of vitreous enamels, (3) resistance of vitreous enamels to abrasion.

Resistance to Thermal Shock in Vitreous Enamels Applied to Flat Surfaces

The method for determining resistance of cooking ware enamels to thermal shock was not conveniently applicable in all cases. A need was felt for a method which would determine resistance to thermal shock of enamels applied to flat surfaces.

Strips were used, 12 by 2 inches, designed for cross-bending tests, testing the enamel near the ends for resistance to thermal shock.

The test consisted of heating the enameled specimen to temperatures of 360°C (680°F) and causing water to drop at a constant rate of one drop in 20 seconds upon the heated enamel for a period of 30 minutes.

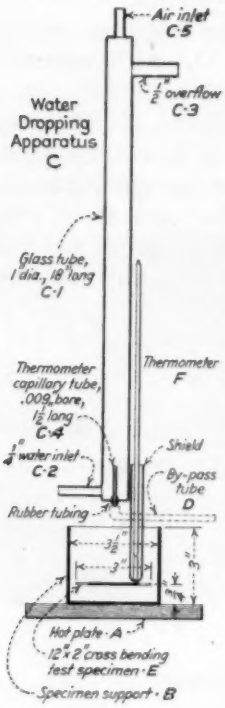

FIG. 1.

Description of Apparatus (See Fig. 1.) *A* is an electric hot plate.

B is a specimen holder which also serves to protect the specimen from air drafts.

C represents the constant flow water dropping equipment of which

C_1 is a glass tube equipped to maintain water at constant level.

C_2 is the water inlet.

C_3 is the water overflow.

C_4 is the thermometer capillary tube through which the water drops onto specimen E.

C_5 is an air inlet to allow air to enter, thus avoiding syphon effect with resultant surge.

D represents a by-pass to carry off water while specimen is being heated.

E represents the enameled specimen in place.

F represents a $-5 + 400$°C thermometer and protecting shield suspended so that shield just clears enameled specimen.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.) Received December 6, 1928.

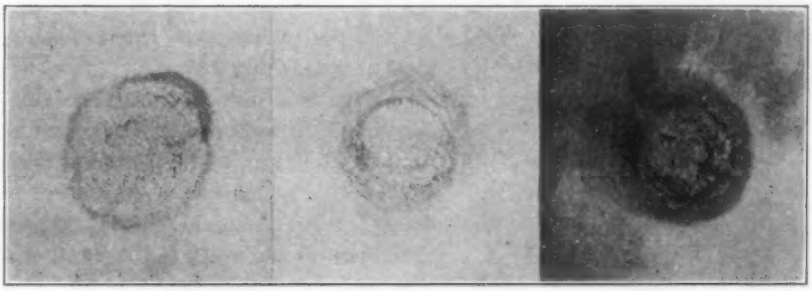
[2] Director Research, Ceramic Materials Division, Titanium Alloy Mfg. Co.

Method of Testing The hot plate is turned on and a blank test piece placed in position, the water by-pass moved so that water drops onto the strip. When the temperature reaches maximum (340°C), the water is by-passed, the blank strip removed, and test piece placed and left until the temperature reaches 360°C. This usually requires 10 minutes.

By-pass *D* is moved so that water drops onto the strip and is allowed to drop for 30 minutes; the by-pass *D* is placed again in position to carry off water and the piece is removed and allowed to cool.

When cool, lamp black is rubbed onto surface and wiped off, showing up the finest crack.

Results In Fig. 2 Enamel A shows the result obtained in one case of an enamel having excellent resistance. It will be noted that enamel at point of water contact has been affected only to the extent of development of numerous fine cracks, the enamel still adhering.



Enamel A Enamel B Enamel C

FIG. 2.—Results of thermal shock tests.

Enamel B, Fig. 2, shows the result of the test in the case of an enamel which did not stand up so well. It will be noted that the failure at point of water contact is not materially different when compared with Enamel A, the difference being in the numerous cracks radiating from the water contact point and also cracks following generally the circular outline of water contact point but being well away from it.

Enamel C, Fig. 2, shows another enamel exhibiting an entirely different type of failure. This enamel became definitely foggy and lost all luster in the area indicated by dark zone away from water contact point. The failure at water contact point is also more pronounced than in Enamels A and B.

It is not thought that the procedure outlined above is necessarily the best one to follow in using this apparatus. Some tests have been made at temperatures below and above 360°C and also tests have been made with

the water beginning to drop as the test piece is placed. It is with the thought that possibly the apparatus or some modification of it may be useful to someone interested in ceramic research that details of apparatus and procedure are submitted.

Determination of Resistance to Mechanical Impact in Vitreous Enamels

An apparatus was needed in which enamels on miniature wash basins as well as enamels on flat pieces could be tested and also one in which the degree of impact could be varied easily using a single weight and also, if necessary, one in which the weight could be varied.

The apparatus shown in Fig. 3 consists of a brass tube which can be easily adjusted as to distance between the lower end of tube and the specimen. Through the walls of the tube at spacings of 3 inches are drilled holes so that the stop-pin can be set at any desired height above specimen. A 1-inch diameter steel ball weighing about 67 g. is used. If a heavier weight is needed a larger diameter tube can be used. We have used, in addition to the tube shown, a larger tube taking a $1^1/_2$-inch diameter steel ball weighing 225 g.

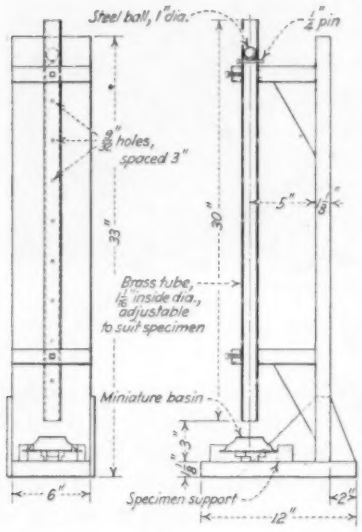


FIG. 3.

In Fig. 3, a miniature wash basin is shown in position but the base is readily adapted to flat pieces and we have found the 12- by 2-inch strips designed for cross-bending machine a convenient specimen shape, testing the enamel at one end by direct impact on white enamel and at opposite end testing the enamel by indirect contact by allowing the ball to drop onto the ground coat side.

The procedure in making tests is as follows:

The specimen is placed and the tube is adjusted so that the ball will just clear the space between surface of specimen and lower end of tube. The pin and ball are placed in position $25^1/_2$ inches above the specimen and by withdrawing the pin the ball is permitted to drop onto specimen. This operation is repeated 10 times at 10-second intervals and the result observed. At times this practice has been varied to suit special cases.

The test pieces can be weighed before and after and the result expressed in terms of loss in weight but usually a visual examination of enamel will answer the purpose.

It is interesting to note that usually an enamel which has excellent resistance to mechanical impact also has a high resistance to cross bending and if this should prove always to be the case then there would seem little need of using the mechanical impact testing machine as the cross-bending machine results are expressible in more definite terms.

Method of Determining Resistance of Vitreous Enamels to Abrasion

In connection with certain experimental work on wet-process enamels we wished to obtain some quantitative information relative to the ability of enamels of various types to withstand the more or less mild abrasive action of alkaline washing and cleanser powders.

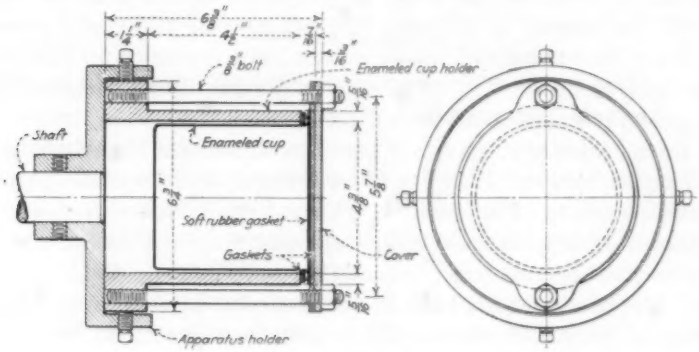


FIG. 4.

The test which was finally developed consists of charging the following materials to a straight walled flat bottom cup enameled inside and out in ground coat and inside only with two coats of the enamel to be tested.

Charge	
Distilled water	500 cc.
A popular cleanser powder	50 g.
A popular washing powder	10 g.
1/4-inch porcelain balls	52

The Method

A counterpoise cup and test cup are first thoroughly cleaned and rinsed with distilled water, dried at 150°C for 1 hour, cooled, and weighed. The charge is then placed in the test cup and this placed in a holder and by means of a soft rubber gasket and clamping device a liquid-tight joint is obtained. The holder is attached to the end of horizontal shaft. Speed of the shaft was 63 r.p.m. The apparatus is rotated for 41 hours and removed from the shaft; the cup is taken from the holder, the charge flushed out and the cup thoroughly cleaned and rinsed with distilled water, dried at 150°C for 1 hour, cooled, and weighed. The difference between

first weight and second weight represents the enamel worn from inside of cup due to abrasive action of the charge.

Figure 4 will serve to show the arrangement and details of equipment used.

The cups used hold one quart and the charge indicated comes somewhat above the center of the vessel.

For each enamel the best possible enameling job was done.

While the apparatus is rotating the noise made by balls is barely audible.

In all of the enamels tested the action has been severe enough to destroy the luster on the enamel all around the inside of the cup but in no case was the luster of enamel on the inside bottom affected.

Although in each case the luster of enamel on the inside of the cup was destroyed the enamel in all cases was left smooth and easily cleanable.

Duplicate determinations made on two cups enameled in one enamel usually check to within 5%. With several different types of enamel tested the gram loss per cup varied from 0.3000 g. to 0.7000 g.

The tests, which are not as yet completed, indicate that there is little if any relation between ability to resist abrasion and the other properties of vitreous enamels. For instance, it seems certain that an enamel which is resistant to fruit acids is not necessarily able to resist abrasion more than one not resistant to fruit acids; in fact, the results indicate that the opposite is true. The series of tests has not been completed to the point where results can be published but work has gone far enough to demonstrate that this apparatus is capable of bringing out in a quantitative manner the differences between enamels of various types.

Experiments have been made with charges other than the one used at the present time; for instance, in some tests 100 g. of carefully selected white sand were used with 50 g. of milled sand and 500 cc. of water, but with such a charge the enamels were affected but to a slight extent and loss in weight in 24 hours was only 0.0025 g. This was not considered enough for purpose of tests. These experiments, however, indicate that vitreous enamels have all the resistance to abrasion needed under normal everyday use.

The details of apparatus and method are submitted with the thought that others may wish to make use of them and it is hoped that they may prove of some value to the enameling industry.

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THE EFFECTS OF SODA, BARIUM, AND ZINC ON THE ELASTICITY AND THERMAL EXPANSION COEFFICIENTS OF GLASS[1]

By L. D. Fetterolf and C. W. Parmelee

ABSTRACT

An investigation is made of the effect, on the elasticity and expansion behavior of a base glass containing 60% SiO_2 and 40% Na_2O, of replacing Na_2O in this glass by ZnO and BaO, respectively. The elasticity and expansion factors of the two oxides, ZnO and BaO, are determined and compared with published results. Elasticity factors of 80 for ZnO, 35 for Na_2O, and 55 for BaO are proposed. Cubical coefficient of expansion factors of 12.5 Na_2O, 5.7 for BaO, and 1.85 for ZnO are also proposed. Neither the factors of Winkelmann and Schott nor those of English and Turner fit very well the results reported in this paper.

I. Introduction

Among the physical properties of glass which in nearly every case partially determine its utility are thermal expansion and elasticity. They are often factors of first importance.

Owing to the relatively low thermal conductivity of glass all parts of a glass object only slowly approach equal temperature when subjected to temperature change. Such temporary differences in temperature result in internal stress.

When a body is distorted by the application of external force the particles of the body suffer relative displacement, which displacement is called a strain. Internal restoring forces called stresses are set up which tend to resist the strain. Substances possessing high elasticity develop a high stress for the corresponding strain. If the stress exceeds a certain limiting value rupture will occur.

It is obvious that the ability of glass to resist thermal shock will depend jointly on the values of the two physical properties mentioned. A high thermal expansion may be offset by low elasticity or vice versa, but high expansion and high elasticity are properties undesirable in a glass which in service may be subjected to thermal shock.

Enamelists in compounding enamels invariably take into consideration the relative expansions of enamel and metal. To the disagreement of the two is attributed a profusion of defects. Unfortunately, the elastic properties of the enamel are often forgotten, probably because of the unavailability of reliable information on the effects of enamel ingredients on this property.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.) Received December 18, 1928.

This investigation was conducted by L. D. Fetterolf in the department of Ceramic Engineering at the University of Illinois in order to meet in part the requirements for the degree of Master of Science.

N J Zinc Co.

Much remains to be done in working out the effect of the various oxides on these two physical properties of glass. The exact chemical constitution of glass remains a matter of speculation; consequently, all attempts made to determine the quantitative effect of glass-forming compounds on physical properties have been and are to be attended with difficulty.

It is to be desired that there be determined for each glass-forming oxide a value which may represent the contribution of each 1% of the oxide to any physical property of the glass in question. The worth of such a series of factors is apparent. Given such a set of factors it would greatly simplify the task of compounding glasses for special purposes.

Such sets of factors are extant and are being used as bases for prediction. There is, however, in many cases a lack of agreement between results of different investigators and lack of correspondence between calculated and observed results.

II. Outline of Problem

A survey of the literature has revealed the fact that little work has been done on the effects of BaO and ZnO on elasticity. The work done on their thermal expansion has for the most part been confined to expansion below 100°C.

The study made was on the oxides BaO, ZnO, Na_2O, and SiO_2. Both BaO and ZnO have been used to a considerable extent in glass and enamels. Acting similarly to PbO, they have in a measure taken the place of that oxide.

One purpose of the investigation was the determination of the effects of BaO and ZnO on elasticity and a comparison of the two in this respect. If possible, it was desired to assign a factor to each and to compare such factors with those which have been assigned to other oxides.

The use of the interferometer made it possible to obtain expansion curves from room temperature to that of the softening point of the glasses. Such curves afforded data for a comparison of the relative effects of ZnO and BaO on thermal expansion and the assignment to them of factors indicative of the extent to which they contribute to expansivity. In addition, the curves were means for the accurate determination of critical annealing temperatures and temperatures arbitrarily selected as the softening points.

The ordinary commercial glass is a substance of chemical complexity and any attempt made to study the effect of any single oxide on a specific property is made difficult by the obscuring effect of other oxides. To simplify the problem, three-component glasses were selected, the two series being Na_2O–ZnO–SiO_2 and Na_2O–BaO–SiO_2. Moreover, wide variations in composition were used in order to produce pronounced effects. Silica was held constant at 60% with ZnO varying from 6 to 30% at com-

position intervals of 6%. Soda made up the remainder. The BaO series was identical except that BaO replaced ZnO.

The melting and fining of a glass result in a material change in composition as a result of corrosion and selective volatilization. Hence, an error of a few tenths of 1% in an oxide having a pronounced effect may become a serious matter.

Realizing the lack of concordance between the batch composition of glass and the melted composition, it was deemed essential that the exact chemical composition of the glasses be known. Chemical analyses in duplicate were accordingly made.

III. Review of Literature

(A) Methods for Measurement of Elasticity

By far the larger number of measurements on the elasticity of glass have been made on a small glass beam supported on knife edges with a load applied at the middle and the deflection measured.

The first systematic study of the elasticity of glass was made by Winkelmann and Schott.[2] The elasticity coefficient for a particular oxide represented the contribution made by 1% of the oxide to the total elasticity of a glass.

Clarke and Turner[3] have used a similar method, the difference being that rods of circular cross-section were used and that the depression of the center of the beam upon application of a load was measured microscopically.

C. A. Bell[4] adopted an acoustical method in which the modulus of elasticity was calculated from the frequency of vibration of a glass rod as determined from the characteristic note emitted by the rod.

An adaption of a method ascribed to Cornu has been used by H. T. Jessop.[5] This method employed a glass beam which was bent by weighting the ends projecting beyond two supporting knife-edges. The amount of flexure was measured by the interference pattern formed by reflection of light from the bent surface of the beam and a cover glass resting on it.

(B) Methods for Measurement of Expansion

(1) Micrometric Method

Most of the methods used for the measurements of thermal expansion have been micrometric. Any elongation, ΔL, is read directly from the micrometer

[2] Jena Glass, Hovestadt (translated by Everett), p. 155.
[3] *Jour. Soc. Glass Tech.*, **3**, 260.
[4] *Phil. Mag.*, **9**, 413.
[5] *Ibid.*, **42**, 551.

head. The mean coefficient of expansion for any temperature interval, ΔT, is given by the relation $C_T = \frac{\Delta L}{L \cdot \Delta T}$. L = length.

M. So[6] investigated the thermal expansion of glass rods which were suspended in an electric tube furnace. A small weight was attached to the lower end of the rod and the expansion measured by means of a microscope rigidly attached to an iron pillar which also supported the glass specimen.

The same method was used by Callender[7] for determining the expansion of hard glass. Contrary to usual practice his measurements were made during cooling.

Danielson[8] used the same principle in his work on the expansion undergone by enamels in the interval from room temperature to about 500°C. Enamel bars were placed horizontally on a sheet of asbestos in a special furnace. Attached to the ends of the bars and hanging through tubes in the ends of the furnace were weighted platinum wires. Length changes were measured by comparator microscopes, sighted alternately on the platinum wires and on a standard length bar kept at constant temperature.

(2) Interferometer Method

The interferometer method was originated by Fizeau and later improved by Pulfrich.

Pulfrich as well as Winkelmann and Weidmann[9] used this method for determining the expansion of commercial glasses but only in the temperature range 15 to 100°C.

Peters and Cragoe[10] in work at the Bureau of Standards used the interferometer method for determining the expansion of commercial glasses to the point of softening as well as the behavior upon contraction in cooling.

(3) Dilatometric Method

The dilatometric method for the expansion of glass was probably developed by DuLong and Petit who filled a glass vessel with mercury and calculated the cubical expansion of the glass by determining the amount of mercury expelled during expansion of the glass.

During the last ten years English and Turner[11] have employed the dilatation method for a very systematic study of the thermal expansion of simple glasses. Carefully annealed cylindrical bulbs have been used as containers for the mercury. Work has, however, been limited to temperatures below 100°C.

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[6] *Tokyo Math. Phys. Soc. Proc.*, **9**, 425.
[7] *Roy. Soc. Trans.*, **178**, 161.
[8] *Jour. Amer. Ceram. Soc.*, **4**, 268 (1921).
[9] Jena Glass, Hovestadt, p. 215.
[10] *Jour. Optical Soc. Amer.*, **4**, 105.
[11] *Jour. Soc. Glass Tech.*, **3**, 239.

IV. Methods Used in Investigation

(A) Elasticity (Cantilever Beam)

(1) Details of Method

The method made use of an accurately dimensioned glass bar used as a cantilever beam, rigidly fixed at one end and free to deflect at the other upon application of a load. The apparatus is shown photographically in Fig. 1. Some modifications were necessary to make possible the determination of the elasticity of bars of rectangular cross-section.

The end of the glass bar was securely fixed in a heavy iron block about 5 inches square and 8 inches in height.

A 500-gram load in every test was applied to the free end of the bar. All bars but two were of such length that the load could be applied at a

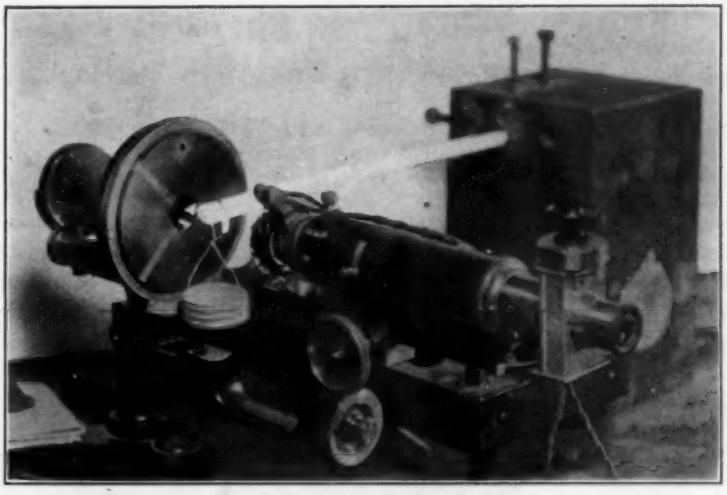

FIG. 1.—Elasticity apparatus.

distance of 20 cm. from the block, making the effective length of the bar 20 cm. This distance was measured as accurately as was possible with a rule marked in tenths of a centimeter. In order to apply the load at the 20-cm. mark a loop of thin wire was passed over the beam at the desired place. A weight attached to the free end of the wire made the effective load 500 grams.

The microscope being focussed on the beam at the point where load was to be applied, the bar was deflected several times by pressure from a finger. This was necessary in order to detect any "slack" in the fixed end of the beam. After several repetitions of this treatment, followed by tightening of the cap-screws, the beam returned to its original position

after the application of load and could be deflected for an actual measurement.

(2) Preparation of Test Specimens Test specimens were prepared from cast bars by grinding to accurate dimensions. Owing to the difficulty involved in the method of casting, the bars were originally of greatly oversize dimensions. These were ground down roughly on a large lap with 60-mesh Carborundum and after annealing were again ground in the same manner. Following this, 200-mesh Carborundum was used for grinding the beams to the desired size. The use of a small square and a thickness gage admirably suited for the work made possible the preparation of very accurately dimensioned bars. The final polishing was done with 400-mesh Carborundum on a smaller lap which had been machined to a true plane surface with special care.

(3) Calculation of Results The elasticity, E, is given by the relation $E = \frac{4\,PL^3}{bd^3\,\Delta}$ in which equation P is the load, L, the length, b, the width, d, the thickness, and Δ, the deflection.

(4) Accuracy For substances like glass there is undoubtedly a large variation in the elasticity among different samples of the same glass. Had it been possible to use more than two specimens of each glass valuable information might have been obtained on what is known in statistics as normal distribution of values, standard deviation, and probable error. A large part of the discrepancies which may appear in the results, it is felt, should be ascribed to normal variation among individuals of a population rather than to inaccuracy of measurement.

(B) Expansion (Interferometer)

(1) Advantages of Method The interferometer for the measurement of expansion has many points to recommend it. Thermal expansion studies may be made as high as 1000°C. The small size of the specimen employed simplifies the problems of uniform heating, temperature control, and uniformity of specimens. Moreover, the interferometer itself is extremely sensitive to temperature change.

(2) Description of Apparatus The apparatus consists essentially of a tube furnace, the interferometer itself, and a Pulfrich apparatus. Referring to the drawing (Fig. 2) the interferometer plates, E, are made of fused quartz which may be heated to 1000°C without injury. The upper and lower surfaces are polished true plane but make small angles with each other in order that all light save that reflected from the two inner surfaces may be diaphragmed out

of view. The specimens, S, in the form of three small cones serve as separators for the plates.

The Pulfrich apparatus, which serves as a source of illumination for the interferometer and which also contains an optical arrangement for observing the interference fringes, is shown to the right. A helium filled Geissler tube, A, using a 10,000-volt current supplies light of known wave-length.

(3) Preparation of Test Pieces Three test pieces in the form of small cones were used. These were taken from the same small cast bar of glass from which samples were taken for chemical analysis. Fragments of glass of suitable size having been chipped from the bar, were ground down to approximately the same size on a lap using Carborundum powder. Following annealing, further grinding

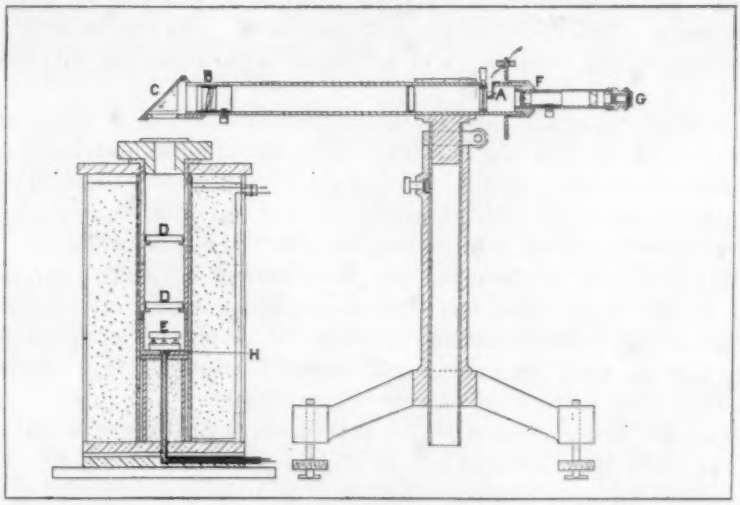

FIG. 2.—Expansion apparatus.

by drawing the base across a fine Carborundum stone brought them to the desired height. Care was taken to obtain a true plane base. The apices of the cones were made blunt, about like a dull lead pencil point. Employing a micrometer it was possible to have the several heights within agreement of a few thousandths of a millimeter.

(4) Method of Set-Up The test specimens having been placed between the quartz plates in the interferometer cup, the Pulfrich apparatus was brought into focus. As only six or eight fringes were desired it was often necessary to adjust the height of one or two of the pieces. By gentle application of pressure with a pencil point on the upper plate and just over a cone, it was possible to tell by means of the attendant increase or decrease of fringes which cone

or cones were too high. Once a stable set-up was secured with the number of fringes desired, the cup was carefully lowered into the furnace with tongs.

(5) Calculation of Expansion The data necessary for calculation of expansion are (1) the height of the test specimens, (2) the number of fringes passing a selected reference point, (3) the temperature at the time of passage of any selected fringe, (4) the wave-length of helium, and (5) a correction for changing index of refraction of air with temperature change.

(6) Accuracy of Method A very high degree of accuracy is ascribed to the interferometer method, for an expansion of only a small fraction of the wave-length of light may be readily detected. Errors which creep in are due to errors in temperature measurement, and to thermal lag of the test specimens. The former error may be estimated with some degree of accuracy but the latter can only be surmised.

A millivoltmeter was used for temperature measurement which could be read to hundredths of a millivolt. This would mean a probable error of about 1°C in temperature. Taking readings at frequent intervals and plotting the results no doubt eliminates most of this error for an expansion curve may be so drawn as to compensate plus and minus errors.

The thermal lag of the expansion pieces cannot introduce appreciable error as the couple used for temperature measurement was calibrated against a couple placed midway between the pieces. It does not seem likely that the small glass pieces used would differ greatly in temperature from that of the furnace atmosphere between them.

Expansion determinations which were in question were repeated. In cases in which the number of fringes in the field of view changed by more than a few, duplicate runs were made in order to learn whether differential expansion or some instability of set-up was responsible. Of course, near the softening temperature the fringes changed greatly in number.

Duplicate runs on the same glass checked so closely that the plotted curves were almost indistinguishable.

(C) Chemical Analysis of Glasses

The methods used for chemical analyses were in general those outlined by the Glass Division Committee on Standards, AMERICAN CERAMIC SOCIETY.[12] Fusion was made with Na_2CO_3, following which the fusion was taken down twice with HCl with intervening filtration. Iron and alumina were determined combined. Recovery of R_2O_3 from SiO_2 and SiO_2 from R_2O_3 was made. BaO was easily and accurately determined as $BaSO_4$. Zinc

[12] *Jour. Amer. Ceram. Soc.*, **11**, 364 (1928).

was precipitated from the R_2O_3 filtrate as $ZnNH_4PO_4$, filtered off, dried at 110°C, and weighed as such. Soda was in all cases determined by difference.

V. Preparation of Glass

(A) Raw Materials and Calculation of Batch

Five glasses were made up for each series, the zinc oxide glasses being designated by Z followed by the batch percentage of ZnO and the barium oxide glasses being designated B followed by the batch percentage of BaO. Silica was held constant throughout at 60%. ZnO varied from 6 to 30% in 6% intervals; the same values and variations were selected for BaO. Soda made up the remainder of the batch.

(B) Mixing

The raw materials being accurately weighed out they were put through a 40-mesh screen and intimately mixed on a large sheet of paper by raising the corners of the sheet and rolling the batch. Thorough mixing is necessary in order to facilitate the melting and aid in the production of a homogeneous glass.

(C) Melting and Fining

The glasses were melted and fined in crucibles placed in gas-fired frit furnaces. After bringing the crucibles to a suitable temperature for melting the batch to a glass, a charge was introduced. Following subsidence of the melt another charge was introduced, and so on until the batch was used up.

When melting was complete the temperature was gradually raised until the glass was of sufficient fluidity to fine itself. During the early period following melting each glass was stirred three times with an iron rod which had previously been sand blasted to remove iron scale. In order to facilitate fining a small amount of ammonium nitrate, wrapped in moist paper, was forced to the bottom of the melt with an iron rod. Raw potato was also tried in this manner.

(D) Casting Bars

The bars used for elasticity were cast by pouring from the crucible into molds made from strips of sheet copper, the molds being placed on well-cleaned steel plates. There was usually sufficient glass for casting eight such bars. A small block of glass was cast after one-half of the glass had been poured. This small sample from the middle of the melt was used for the chemical analysis and for the expansion pieces.

(E) Cooling of Glass

As soon as the cast bars became sufficiently rigid for handling they were transferred from the steel plate to saggers in which they were buried in

powdered Sil-O-Cel. This method of casting and treatment for cooling was successful in all respects.

VI. Annealing Treatment

(A) Annealing Furnace

The furnace used for annealing was an automatically controlled electric furnace having inside dimensions of 12 by 16 by 24 inches. The pieces to be annealed were placed on a thin steel plate which was raised by means of small tile so that it occupied a position in the central part of the furnace.

(B) Annealing Temperature

The annealing temperature was determined by the deformation of a glass rod 1 mm. in diameter which was placed on the edge of a small porcelain tile. The rod projected one inch on either side of the tile and the tile was placed so that it was in the middle of the steel plate.

The temperature was raised at the normal heating rate of the furnace. This time varied from 30 to 50 minutes depending on the glass. Temperature was measured by means of a base metal couple and millivoltmeter. The junction was placed as closely as possible to the glass rod used for determining the annealing temperature.

Upon indication of deformation of the rod the temperature was read and the current shut off. The temperature, however, continued to rise somewhat. This was desirable because the much larger glass specimens resting on the steel plate were undoubtedly at a lower temperature.

(C) Rate of Cooling

The annealing treatment described carried the glass considerably above the critical annealing temperature. For this reason the furnace was allowed to cool 50°C in the first 40 minutes and 60°C an hour in the next two hours. No effort was made to control the rate of cooling below this point but the normal cooling rate of the furnace was low.

(D) Examination for Stress

The annealed glass was examined for stress by observation of the glass between crossed nicols of a microscope. A well-annealed specimen so examined appears uniformly dark while one poorly annealed shows irregular bands ranging from yellow down through white to dark gray, all depending on the thickness of the glass and the state of stress.

VII. Results

(A) Description of Glasses

There follows a tabulation of the glasses made, with the temperature at which each was fined, and the duration of heat treatment after complete melting.

TABLE I

Glass	Temperature, °C	Time (hours)
B6	1200	8½
B12	1225	6½
B18	1275	7½
B24	1300	6
B30	1325	6½
Z6	1225	7½
Z12	1275	5½
Z18	1350	12
Z24	1400	7
Z30	1400	9

The results obtained were unsatisfactory in only one respect, namely, that the melts could not be completely fined.

Had it been possible to make larger batches the glasses high in soda would no doubt have been perfectly fined in the time indicated. Whether a longer period of fining of the small batches would have improved results is problematical. All the glasses made were vigorously corrosive and longer fining periods were impossible because of failure of the crucibles. It may be said that 5 or 6 hours of continued fining did not materially improve results.

Bubbles were most numerous in the upper portion of the melt, the lower portion being in nearly all cases relatively free. Eight bars being cast from each glass, it was possible to select two which were felt to be suitable for giving at least comparative results on elasticity. The bubbles were so few that there was no difficulty in selecting expansion pieces which were devoid of them.

All the glasses high in soda had a dull appearance which became less marked with increasing ZnO or BaO. B24, B30, Z24, and Z30 were good glasses. Z24 and Z30 possessed particular brilliance, to a much greater degree than the corresponding barium glasses.

Examination of the glasses two months after preparation revealed the fact that B6 and Z6 were covered with a white powder of Na_2CO_3 resulting from the carbonation of soda. All the other members of the BaO series were scummed, particularly B12 and B18. Z12 and Z18 were scummed to a less extent than the corresponding barium glasses. The brilliance of Z24 and Z30 had not been noticeably impaired.

(B) Chemical Analysis

The compositions used in the research were obtained by taking the averages of duplicate analyses, correcting the resulting percentages for loss on ignition, and expressing the percentages in nearest tenths of a per cent.

Compositions reduced to the basis explained, together with the corresponding batch compositions, follow in Table II.

TABLE II

	Composition by Analysis %				Batch Composition %		
	SiO_2	R_2O_3	BaO	Na_2O	SiO_2	BaO	Na_2O
B6	60.0	1.7	6.0	32.3	60.0	6.0	34.0
B12	60.1	0.9	12.2	26.8	60.0	12.0	28.0
B18	59.6	1.3	18.2	20.9	60.0	18.0	22.0
B24	59.4	0.9	24.0	15.7	60.0	24.0	16.0
B30	59.4	0.7	30.0	9.9	60.0	30.0	10.0
			ZnO			ZnO	
Z6	59.7	1.6	5.8	32.9	60.0	6.0	34.0
Z12	59.9	0.6	11.9	27.6	60.0	12.0	28.0
Z18	59.1	1.9	17.4	21.6	60.0	18.0	22.0
Z24	59.1	0.6	23.8	16.5	60.0	24.0	16.0
Z30	58.8	0.5	29.7	10.9	60.0	30.0	10.0

(C) Annealing

It is in no wise the intent that the results to be given on annealing temperatures are to be taken as the accurate annealing temperatures for the glasses studied. The method used was crude and was intended only to indicate the temperature of softening. All that was desired was that the critical annealing temperature be exceeded and that the temperature of softening be not greatly exceeded. The specimens annealed were not finished test specimens; consequently, slight deformation of them was of no moment.

Without question the upper annealing temperature was exceeded in every case. Evidence for this was the fact that the glass took on a very slight fire polish. Moreover, it is certain that a temperature sufficient to cause deformation of a horizontal glass rod 1 mm. in diameter and 2.5 cms. long would be too high for annealing a heavy glass object without distortion. Very likely the results are comparable with those which would be obtained in a cone deformation test.

Table III gives the softening temperatures of the various glasses as determined by deformation of the small glass rods.

TABLE III

	Softening temperature		Softening temperature
Z6	482	B6	490
Z12	524	B12	523
Z18	571	B18	530
Z24	629	B24	557
Z30	671	B30	579

The effect of ZnO in increasing the refractoriness of a glass is apparent. A more strict comparison of softening temperatures as indicated by the expansion will be given later.

(D) Elasticity

(1) Comparison of Effect of BaO and ZnO

The values obtained for moduli of elasticity expressed in kilograms per square millimeter are given in following table.

	Bar No. 1	Bar No. 2	Average
Z6	4920	4980	4950
Z12	5570	5570	5570
Z18	5860	5690	5780
Z24	6070	5760	5910
Z30	6500	6470	6480
B6	5350	5400	5360
B12	5200	5270	5240
B18	5600	5580	5590
B24	5680	5520	5600
B30	5960	5710	5830

It is to be noted that as ZnO replaces Na_2O the modulus of elasticity increases rapidly and quite systematically. In general, replacement of Na_2O by BaO results in a higher modulus but the effect is much less pronounced than in the case of ZnO. The results are more closely grouped about a central value. In the B series a regular sequence of values is disturbed by the fact that B12 has a lower modulus than B6. Both specimens of each glass gave results in close agreement, consequently the average values are believed to represent the actual moduli of B6 and B12. It may be that defects in B12 were responsible for a low value for it.

It is to be recalled that none of the glasses prepared was perfectly fined but that bars formed from the glass in the lower part of the crucibles were quite good and did not differ much among themselves in the amount of bubbles. No doubt comparative results were obtained even if the bubbles present did somewhat lower the values for moduli. It is not believed, however, that bubbles were present in sufficient number or size to greatly reduce the values for moduli. Values for glass range between 5000 and 7000 kg./mm^2., both for commercial and experimental glasses; consequently, the values which have been given as results are within the expected limits.

The fact that the rods used were not perfectly annealed and were not fire-polished may call into question the results. No investigation was made on the effect of state of strain or the influence of skin effect. Analogy with the case of annealed and unannealed metals might lead one to believe that annealing would very materially influence the elasticity. The two cases are not similar, however, because the annealing of metals results in modification of crystalline structure which is not true of glass. In a recent comprehensive investigation Gehlhoff and Thomas[13] found that state of annealing and the presence or otherwise of a fire-polished surface had very little effect on results.

(2) Comparison of Results with Those of Other Investigators

Winkelmann and Schott assigned to the various oxides factors expressed in kg.-mm^2. which were assumed to represent the contribution made by each 1% of the oxide to the total elasticity of the glass. A set of factors has been derived for Na_2O,

[13] *Jour. Soc. Glass Tech.*, **11** [A], 246.

BaO, and ZnO based on the results obtained in this investigation. To make the comparison of results fair, the Winkelmann and Schott factor for SiO_2 was used. Factors were obtained by the simultaneous solution of pairs of equations built up on the percentage compositions of the glasses and the moduli of elasticity of the glasses.

The average value obtained for Na_2O in the Z series by 6 pairs of equations was 20 and for ZnO the value obtained was 80. The average results for the B series were $Na_2O = 35$ and $BaO = 55$.

Whereas Winkelmann and Schott assigned a value of 65 to SiO_2, Clarke and Turner[14] have more recently given the same oxide a value of 40. Using this value for SiO_2 the average values obtained by the writer are: for the Z series $Na_2O = 60$, and $ZnO = 115$; for the B series $Na_2O = 75$, and $BaO = 90$. The results are set down below.

	Winkelmann and Schott	A	Clarke and Turner	B
SiO_2	65		40	
Na_2O	100	(20, 35)	110	(60, 75)
BaO	100	55		90
ZnO	15	80		115

The column headed Winkelmann and Schott gives the factors which are due to Winkelmann and Schott. Column A gives the factors the writer has obtained using the Winkelmann and Schott factor for SiO_2; Column B, those obtained using the Clarke and Turner factor of 40 for SiO_2. Two values are recorded for Na_2O in Columns A and B, the first value being in each case that derived from the ZnO glasses and the second, that from the BaO.

The result of most interest is the value obtained for ZnO which is more than 5 times that given by Winkelmann and Schott. Were 15 a correct factor, ZnO would be tremendously effective in reducing the elasticity of a glass. This study has shown without question that ZnO greatly increases elasticity when substituted for Na_2O. Since the increase due to ZnO is a fact, the factor for Na_2O must be less than that for ZnO, which was the result obtained.

According to Winkelmann and Schott, BaO and Na_2O have equal effect on elasticity. Were this true, replacement of Na_2O by BaO would result in no change in elasticity; the contrary was true in this study. BaO increased the modulus and the factors derived are indication of the relative effects of BaO and Na_2O in this respect.

The factors given in Column B above need no comment other than that they are relatively higher than those of Column A. This would be expected in view of the fact that the greatly reduced silica factor of Clarke and Turner was used in the calculation.

[14] *Jour. Soc. Glass Tech.*, **3**, 260.

(E) Expansion

(1) Characteristics of Expansion Curves

In Fig. 3 are plotted the expansion curves for all the glasses studied. Curves for the Z series are shown in full lines and those for the B series, in broken lines. Although the curves are accurately drawn they are not strictly comparable for initial temperatures varied as much as 13° among the several glasses.

One more obvious feature of the curves is that expansion is very regular to a relatively high temperature. The slopes of the curves gradually increase indicating a more rapid rate of expansion with increasing temperature. Later discussion of expansion within defined temperature intervals will point out the magnitude of the increasing rate.

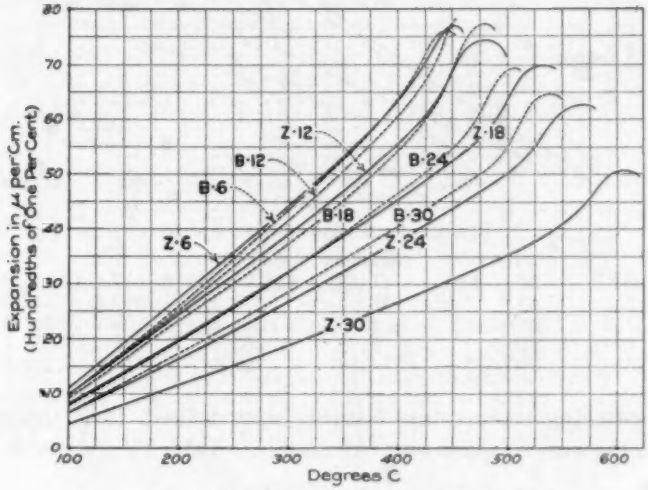

FIG. 3.—Expansion curves, 100°C to softening point.

Beyond the more regular portion of a curve there occurs a quite well-defined break at which point the rate of expansion increases markedly. This point occurs within about 50° of the temperature of maximum expansion. Other investigators have found this break to be the critical annealing temperature, the minimum temperature at which strain may be relieved.[15] Unannealed glasses at this point show decreased expansion or zero expansion until all strain is relieved. This being true, the curves show that annealing was perfect. Following the break described, the expansion becomes quite regular through a short temperature interval. There then occurs a decreasing rate of expansion due to softening which persists to the temperature of zero expansion, the temperature corre-

[15] Peters and Cragoe, *op. cit.;* Pietempol, *Chem. and Met. Eng.*, **23**, 876.

sponding to the abscissa of the point of tangency of a tangent of zero slope. (This temperature has been arbitrarily selected as the softening temperature as given by the expansion curves.) At higher temperatures a contraction takes place as would be expected when the glass is sufficiently soft to deform.

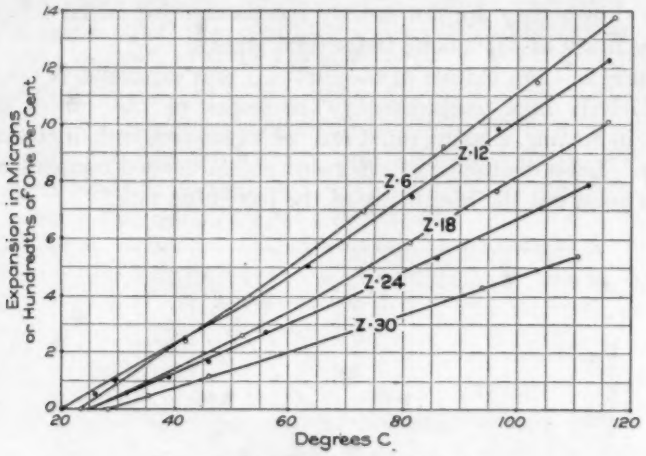

FIG. 4.—Expansion curves: Z series.

	Interval, °C	Expansion	Cu. exp./°C	E. & T.	W. & S.
Z6	$23^1/_2$–100	11.1μ	435.3×10^{-7}	437.5	395.2
Z12	20 – "	10.06	377.2	369.6	348.3
Z18	25 – "	8.14	325.5	293.5	304.1
Z24	$23^1/_2$– "	6.68	262.0	228.2	258.4
Z30	$28^1/_2$– "	4.66	195.6	156.9	212.5

The softening temperature having been defined, it is interesting to compare the various glasses in that respect. Table IV gives such information.

TABLE IV

	Softening temperature, °C		Softening temperature, °C	Diff. Z and B
Z6	450	B6	443	7°
Z12	480	B12	460	20
Z18	530	B18	480	50
Z24	568	B24	505	63
Z30	605	B30	536	69

These temperatures are all lower than those given in Table III. The expansion test pieces having deformed under the load of the upper interferometer plate, the discrepancy is accounted for.

(2) Total Expansion The total expansion of the various glasses hardly merits discussion or tabulation of figures. Increasing ZnO resulted in a regular decrease in total expansion. The same was true for BaO except that B6 has a smaller total expansion than B12. Obviously, a high expansion glass need not have a larger total expansion

than a glass of lower expansion. The temperature of softening determines in part such relationship.

(3) Temperature Interval Expansions Figures 4 and 8 show the expansions of the glasses of the Z and B series, respectively, in the interval room temperature to 100°C. Results are plotted in the same manner as on Fig. 3 save that the scales are magnified. Points are scattered somewhat above and below the curves but on such a magnified scale the error in temperature measurement already discussed is certain to be apparent.

It is seen that in this interval the expansions are indeed nearly linear. This is true without approximation to and above about 55°. At that temperature there seems to be a distinct break in the curves. Whether

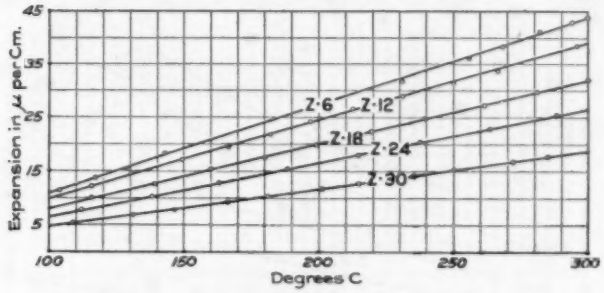

FIG. 5.—Expansion curves: Z series, 100–300°C.

	Interval, °C	Expansion	Cu. exp./°C
Z6	100–300	32.70μ	490.5×10^{-7}
Z12	"	29.10	436.5
Z18	"	23.80	357.0
Z24	"	20.00	300.0
Z30	"	13.90	208.5

this is inherent in the nature of glass, due to thermal lag, or in some way related to the removal of possible moisture film from the test pieces is unknown. No reference to such a peculiarity has been discovered in the literature. It is highly improbable that thermal lag can be held responsible for such an abrupt effect.

On Figs. 4, 5, 6, 8, 9, and 10 there are tabulated the expansions for the various glasses together with the corresponding temperature intervals. It has been the practice in discussion of expansion of glass to express the value in terms of cubical expansion per degree C. The expansion in cm./cm./°C is found by multiplying the linear expansion in microns for the interval by 0.0001 and dividing by the number of degrees in the interval. Multiplication by 3 gives a very close approximation to the cubical expansion. The cubical expansions follow.

TABLE V

Glass	Interval, °C	Cu. exp./°C	100–300°C	300–400°C	300–500°C
Z6	23.5–100	435.3×10^{-7}	490.5×10^{-7}	568.5×10^{-7}	
Z12	20.0–100	377.2	436.5	483.6	
Z18	25.0–100	325.5	357.0	402.0	
Z24	23.5–100	262.0	300.0	337.5	
Z30	28.5–100	195.6	208.5		239.2
B6	33.0–100	436.5	513.0	572.0	
B12	24.5–100	400.0	468.6	556.8	
B18	29.5–100	371.7	418.5	510.0	
B24	28.5–100	341.1	368.3	415.5	
B30	31.5–100	293.5	324.0	357.0	

It is to be noted that BaO is very effective in reducing expansion. ZnO, however, is much more effective in the same respect. Replacement of 24% of Na_2O by an equivalent amount of ZnO reduced the expansion to much less than one-half, being almost twice as effective as BaO.

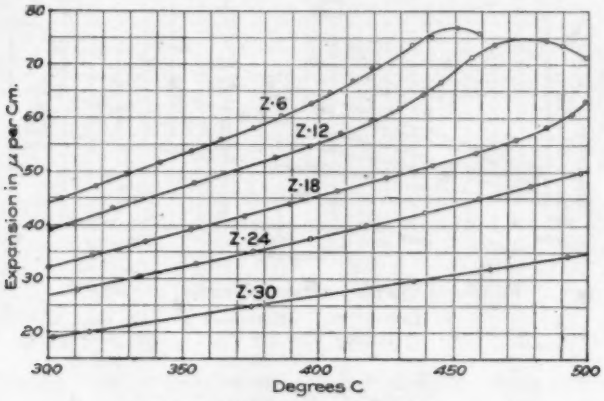

FIG. 6.—Z-Series, 300–500°C.

	Interval, °C	Expansion	Cu. exp./°C
Z6	300–400	18.95μ	568.5×10^{-7}
Z12	" "	16.12	483.6
Z18	" "	13.40	402.0
Z24	" "	11.25	337.5
Z30	" 500	15.95	239.2

Figures 5 and 9 give the expansion curves for the interval 100 to 300°C. These lines have been drawn with a straight edge in such a manner as to distribute points evenly above and below the lines. Straight lines indicate linear expansion and the expansion in this interval is in reality almost linear.

On Figs. 6 and 10 are shown the expansion curves for the interval 300 to 500° or 300° to the softening point. For most of the glasses the expansion is practically linear from 300 to 400°. Accordingly, cubical expansion is given for the interval for the sake of comparison with that in the other intervals.

(4) Calculation of Expansion Coefficients

The first attempt to derive cubical coefficients of expansion for BaO and ZnO was made to test the assumption that the coefficients for Na_2O, SiO_2, and Al_2O_3, as given by English and Turner, as well as by Winkelmann and Schott, would apply. Obviously, one set of factors or both are wholly or partially in error in these cases.

	Expansion Factors	
	English and Turner	Winkelmann and Schott
Na_2O	12.96	10.0
SiO_2	0.15	0.8
Al_2O_3	0.52	5.0

Calculations were made by setting up equations involving the percentage composition of each glass and the expansion of the glass in the interval

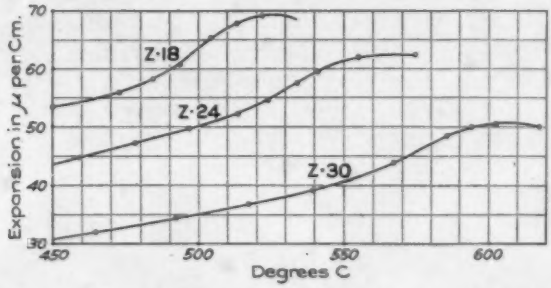

FIG. 7.—Expansion curves, Z series, 450° to softening point.

room temperature to 100°C. For example, for B6 the equation using English and Turner factors was:

$$6.0BaO + 60.0 \times 0.15SiO_2 + 1.7R_2O_3 \times 1.0 + 32.3Na_2O \times 12.96 = 436.5$$

Solution of the equation for BaO gave the cubical expansion attributable to 1% of BaO.

Since the R_2O_3 as given by analysis contained Fe_2O_3, revision of the Al_2O_3 factor given by English and Turner seemed necessary. Work done by English and Turner on similar Zn and Ba glasses showed that approximately one-tenth of the R_2O_3 content was Fe_2O_3[16]. Mayer and Havas[17] give a factor of 4.0 for Fe_2O_3. Assuming that one-tenth of the R_2O_3 is Fe_2O_3 the English and Turner factor of 0.52 for Al_2O_3 would become about 1.0.

[16] *Jour. Amer. Ceram. Soc.*, **10**, 558 (1927).

[17] *Sprechsaal*, **44**, 188.

Results given by this method of calculation follow. The columns headed English and Turner give the factors for ZnO and BaO as derived by the use of English and Turner factors. The columns headed Winkelmann and Schott give the results on the basis of Winkelmann and Schott factors.

	English and Turner	Winkelmann and Schott		English and Turner	Winkelmann and Schott
Z6	−0.2	8.7	B6	1.3	9.5
Z12	0.8	4.2	B12	3.5	6.5
Z18	2.0	3.0	B18	5.0	6.0
Z24	1.6	2.0	B24	5.3	5.5
Z30	1.5	1.2	B30	5.2	4.8

Although there is a systematic variation in the factors so derived it is obvious that the factors assumed need revision so far at least as the glasses in question are concerned.

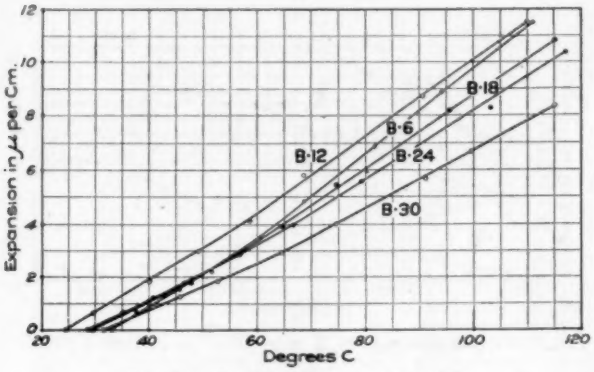

FIG. 8.—Expansion curves, B series.

	Interval, °C	Exp.	Cu. exp./°C	E. & T.	W. & S.
B6	33 – 100	9.75μ	436.5×10^{-7}	459.9×10^{-7}	397.5×10^{-7}
B12	$24^1/_2$ "	10.06	400.0	420.3	357.2
B18	$29^1/_2$ "	8.74	371.7	375.3	317.8
B24	$28^1/_2$ "	8.14	341.1	337.7	281.0
B30	$31^1/_2$ "	6.70	293.5	293.6	240.0

The method finally adopted accepted the factor of English and Turner for SiO_2 and calculated factors for Na_2O, BaO, and ZnO by simultaneous solution of pairs of equations. The assumption is made that SiO_2 carries into a silicate glass the expansion of fused quartz which has a cubical expansion factor of 0.15. The validity of the assumption may be open to some question but it is supported by the fact that fused silica carries with it into a glass its own specific heat and some other physical properties. The experimental work of English and Turner indicates that this is true for thermal expansion.[18] After a study of the thermal expansion of sodium

[18] *Jour. Soc. Glass Tech.*, **5**, 121.

silicate glasses, the expansion was plotted against per cent of silica. The maximum silica content was about 80% but extrapolation of the expansion curve gave a value of 0.15 for silica alone. The curve being straight it could only be concluded that silica carried into the glass the expansion of fused quartz.

The derivation of factors for Na_2O and ZnO was obtained by simultaneous solution of equations based on the composition and expansion of the following pairs of glasses: Z6–Z12, Z12–Z18, Z18–Z24, Z24–Z30, Z6–Z30, and Z12–Z24. Factors for Na_2O obtained in the proper order were 12.66, 11.84, 13.71, 13.3, 12.7, and 12.48. Factors for ZnO were in the same order: 1.55, 3.45, 1.11, 1.40, 1.64, and 1.97. The averages of these values are: Na_2O = 12.77 and ZnO = 1.85.

In determining the coefficients for Na_2O and BaO the corresponding pairs of equations were used: B6–B12, B12–B18, etc. Values obtained

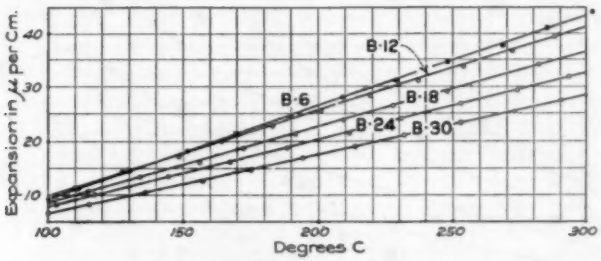

FIG. 9.—Expansion curves, B Series, 100 to 300°C.

	Interval, °C	Expansion	Cu. exp./°C
B6	100–300	34.20μ	513.0×10^{-7}
B12	" "	31.25	468.6
B18	" "	27.90	418.5
B24	" "	24.55	368.3
B30	" "	21.60	324.0

for Na_2O were 12.23, 11.55, and 12.25, 13.38, 12.18, and 11.67; for BaO, 5.11, 6.61, 5.79, 5.05, 5.45, and 6.17. The averages of these values are: Na_2O = 12.21 and BaO = 5.70.

Comparison of the averages obtained for Na_2O show that it has practically the same effect on expansion in the two series of glasses. The six values obtained for Na_2O in each series of glasses are in quite close agreement, indicating that the expansion due to soda is an additive function of the amount of the oxide. The same conclusion may be drawn with respect to ZnO and BaO. BaO carries into the glasses less than half the expansion of Na_2O, and ZnO about one-seventh that of Na_2O.

(5) Comparison with Results of Other Investigators

The values for the cubical coefficients of expansion given by English and Turner and Winkelmann and Schott are the only ones which have met with wide acceptance. Mayer and Havas have done con-

siderable work and their results are confirmatory of those of Winkelmann and Schott. The tendency is to cling to the empirically derived factors of the last-named investigators even though all recent work has proved their values to be wholly or partially inapplicable.

The English and Turner and Winkelmann and Schott factors are placed beside those found in this investigation.

	A	English and Turner	Winkelmann and Schott
SiO_2		0.15	0.8
Na_2O	12.5	12.96	10.0
BaO	5.7	5.2	3.0
ZnO	1.85	0.21	1.8

The English and Turner factor for SiO_2 having been used in obtaining the values in Column A it is realized that chances favor closer agreement

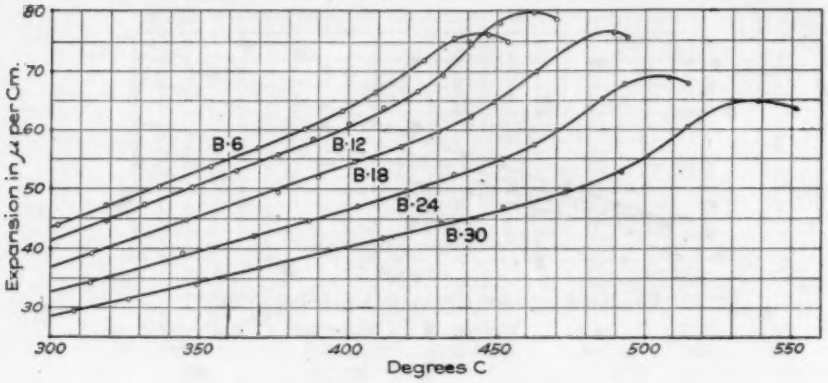

FIG. 10.—Expansion curves, B Series.

	Interval, °C	Expansion	Cu. exp./°C
B6	300–380	15.25	572.0×10^{-7}
B12	" "	14.85	556.8
B18	"–400	17.00	510.0
B24	" "	13.85	415.5
B30	" "	11.90	357.0

with the English and Turner factors than with the Winkelmann and Schott factors. The factor for Na_2O found is in close agreement with that of English and Turner as is also the factor for BaO. The factor for ZnO, however, is in almost exact agreement with that of Winkelmann and Schott. The results show that the factors of English and Turner are in general more acceptable but that the factor of 0.21 for ZnO is unquestionably low.

It is of interest to compare the observed expansions of the various glasses with the expansions calculated using the set of expansion factors of English and Turner and again with those calculated on the basis of the Winkelmann and Schott factors. Comparison is legitimate only in the

interval below 100°C for the factors given by the investigators named were derived from thermal expansion data obtained below the limit stated. There is here given the observed expansion of the glasses, that calculated on the basis of English and Turner factors, that calculated using Winkelmann and Schott factors, and the difference between each calculated expansion and observed expansion.

	Observed	English and Turner	Diff.	Winkelmann and Schott	Diff.
B6	436.5×10^{-7}	459.9×10^{-7}	+23.4	397.5×10^{-7}	−39.0
B12	400.0	420.3	+20.3	357.2	−42.8
B18	371.7	375.3	+ 3.6	317.8	−53.7
B24	341.1	337.7	− 3.4	281.0	−60.1
B30	293.5	293.6	+ 0.1	240.0	−53.5
Z6	435.3	437.5	+ 2.3	395.2	−40.1
Z12	377.2	369.6	− 7.6	348.3	−28.9
Z18	325.5	293.5	−32.0	304.1	−21.4
Z24	262.0	228.2	−33.8	258.4	− 3.6
Z30	195.6	156.9	−38.7	212.5	+17.0

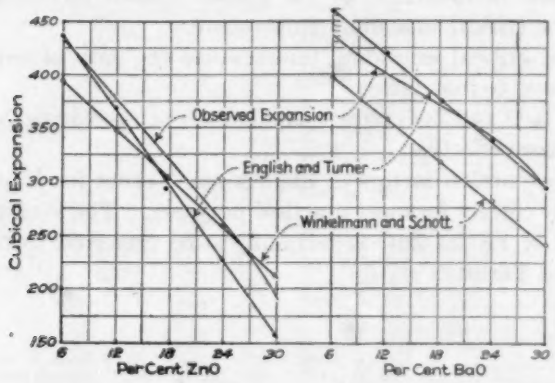

FIG. 11.—Graphs showing relation between observed expansions and expansions calculated on bases of E. & T. and W. & S. factors.

Figure 11 shows in graphical form the comparative results. It is seen that for the ZnO glasses the calculated expansions are in agreement with the observed at opposite extremes of the curves. The Winkelmann and Schott expansions for the BaO glasses are uniformly low while those of English and Turner check quite well. Unquestionably, neither set of factors is applicable to all glasses but it would seem that best results are to be obtained by use of the values published by English and Turner.

VIII. Conclusions

(1) The reported impossibility of fining glass in small batches is confirmed.

(2) BaO and more particularly ZnO impart brilliance to simple glasses of the type studied. Moreover, they greatly improve durability.

(3) Replacement of Na_2O by either BaO or ZnO increases the softening temperature of a glass. ZnO is considerably more effective than BaO in this respect.

(4) Both BaO and ZnO when substituted for Na_2O increase the modulus of elasticity of a glass. Again, the effect of ZnO is much more pronounced.

(5) The generally accepted factor of 15 for modulus of elasticity for ZnO as given by Winkelmann and Schott is undoubtedly low. A factor of 80 is proposed.

(6) Equal effectiveness of Na_2O and BaO in contribution to elasticity is disputed. Factors of 35 for Na_2O and 55 for BaO in place of 100 for each are more in harmony with results. The values may be somewhat low but proportionately so.

(7) The rate of expansion of the glasses studied increases somewhat even below the critical annealing temperature.

(8) At the critical annealing temperature the rate of expansion increases from two to four times.

(9) Both BaO and ZnO reduce expansion when replacing Na_2O. ZnO is the much more effective.

(10) The expansion factors of English and Turner for Na_2O and BaO are sufficiently correct for most practical purposes. The Winkelmann and Schott factor of 1.8 for ZnO is certainly to be preferred to that of 0.21 of English and Turner.

CERAMIC ABSTRACTS

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[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

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Abrasives

Proper choice of wheels on large steel parts. FRED B. JACOBS. *Abrasive Ind.*, **10** [1], 1–4 (1928).—Manganese steel cannot be machined by ordinary cutting tools and its fabrication is distinctly an abrasive operation. J. illustrates and describes a number of interesting grinding operations on manganese steel at the Marion Steam Shovel Co., Marion, Ohio, and also a few grinding operations on carbon steel wherein grinding has been found to be more economical than turning in finishing comparatively large units. E.P.R.

Special abrasive tools solve grinding problems on British railway. C. B. COLLETT. *Abrasive Ind.*, **10** [1], 5–8 (1928).—C. explains at length a number of interesting grinding operations that are typical of British practice, and points out how abrasive operations save time and money in railway shop practice. E.P.R.

Motor drives for precision grinding machines. R. E. HARRISON. *Abrasive Ind.*, **10** [1], 9–11 (1928).—The most prolific source of difficulty in grinding is vibration, and until motors are free from vibration, it is doubtful whether mounting the motor directly on the grinding wheel spindle will become general. Vibrations due to the end movement of the armature are rare but vibrations due to lack of dynamic balance are frequent. An armature will be produced in correct dynamic balance. Then the main drive motor will be an integral part of the wheel head. E.P.R.

Exhibit abrasives. ANON. *Abrasive Ind.*, **10** [1], 11 (1928).—Prominent among the interesting displays at the recent engineering exhibition held at Olympia, London, by the Machine Tool Trades Assn. was that of the Carborundum Co. E.P.R.

Nonferrous metals present. ANON. *Abrasive Ind.*, **10** [1], 15–18 (1929).—Interesting and peculiar grinding problems are discussed. E.P.R.

Grinding high-speed steel. B. WYNN. *Abrasive Ind.*, **10** [1], 18 (1929).—In grinding high speed steel it is necessary to observe precautions not necessary with carbon steel. Tools said to have been spoiled by heat may have been ground improperly. Slow speeds and light cuts are required in grinding high speed steel. If care is not exercised, grinding dry will soften a very thin layer on the surface caused by a wheel being slightly hard. A trickle of water will cool locally causing the steel to shrink where the water strikes it, causing checks and surface cracks due to the unequal stresses set up within the material. Burning always results if hardened and tempered tools are ground from the body to the point of the tool. The life of a cutter can be prolonged by frequent sharpening. Hobs must be kept sharp, the face of the teeth radial, and flutes evenly spaced. A coarse, medium hard wheel is recommended. Light off-hand grinding of lathe and planer tools requires a medium wheel whereas heavy off-hand grinding requires a coarser, harder wheel. Soft free-cutting wheels should be used in regrinding reamer blades and only enough metal removed to touch the cutting edges to prolong the life of the blades and insure better work. Grinding drill points requires patience and ex-

perience to grind by hand. After grinding the cutting edges of a drill the point is thinned. This is called pointing. A groove is ground on each side of the flat between the cutting edges, and owing to the difference in the depth of the flutes it also equalizes the length of the edges. For this class of work a 46-grain L-grade aluminous abrasive wheel is used. High speed steel knives should be ground dry except when they can be flooded with a solution of water and sal soda, or a modern grinding compound. An aluminous abrasive wheel from 30 to 36 grit, I- to K-grade silicate process, is recommended for this class of work. The operating speed is from 3500 to 4000 surface feet per minute. E.P.R.

Uniform abrasive necessary for gear lapping. H. J. WILLIS. *Abrasive Ind.*, **10** [1], 19–20 (1929).—When lapping, whether for smoothing, fault correcting, or gear recovery, the lapping media should be carefully selected. No one abrasive is suitable for more than a few types of gears. Hardened gears, having a sliding action require a hard sharp grain, which, if used on soft gears having a rolling action, would prove disastrous. Gears having both rolling and sliding actions require a different abrasive than either. Natural abrasives, such as emery and various diatomaceous earths related to the opal sometimes known as tripoli or kieselguhr, are rather ragged in shape, soft and uncertain in quality. Corundum is better shaped for some work, but is easily broken down. All natural abrasives have a wide variation of purity, seriously affecting the quality of work they do. Generally speaking, they are nearly all suitable for polishing only. Long research in gear lapping has demonstrated that a closely graded grain that will cut fast enough for commercial lapping is too harsh and will leave deep grain marks. Consequently packing with a well-selected grit is required to combine a good finish with speed. The use of oils, soaps, and greases with abrasives as lapping media have, in common, some very serious defects, many of which are listed. E.P.R.

Grind malleable iron economically. ANON. *Abrasive Ind.*, **10** [1], 20–21 (1929).—In many foundries snagging of castings is looked upon as a necessary evil, and an operation that can be performed by unskilled labor, often without resorting to a system for computing the grinding costs accurately. However, where many wheels are in constant use, lack of system will increase the cleaning room expense enormously. E.P.R.

Crankshafts must be accurate. ANON. *Abrasive Ind.*, **10** [1], 22–23 (1929).—Satisfactory results can be secured only by the use of machines built especially for crankshaft grinding, of which there are several makes. E.P.R.

Test wet disks. ANON. *Abrasive Ind.*, **10** [1], 23 (1929).—Wet disk grinding was first suggested to the trade three years ago and several types of abrasive disks suitable for use in water were offered. Results obtained up to the present time, however, have been rather disappointing. E.P.R.

Double disk grinder finishes nonmetallic materials. ANON. *Abrasive Ind.*, **10** [1], 24–25 (1929).—Interesting examples of disk grinding of nonmetallic materials are described. The grinding members in most cases are thick abrasive circles developed by the Gardner Machine Co., Beloit, Wis. It is pointed out that the successful grinding of nonmetallic work depends far more on the selection of suitable cutting members than upon the machines. E.P.R.

Abrasive engineering progress. ANON. *Abrasive Ind.*, **10** [1], 40–44 (1929).—The following machines are described: a surface grinder which operates continuously, an amplifying gage, a universal cutter and tool grinder, a cup wheel grinder, a floor grinder and buffer, and steel rule. E.P.R.

High-speed grinder and snagger. ANON. *Brass World and Platers' Guide*, **24** [9], 277 (1928).—The U. S. Electrical Tool Co., Cincinnati, O., manufacturer of electric grinder and snagger, claims that a speed of 9500 surface feet per minute can be attained

with wheels 30 in. in diameter and $2^1/_2$- to 3-in. face, 18-in. hole, operating on 40 or 60 cycles. E.P.R.

Nature of polishing action. ANON. *Brass World and Platers' Guide*, **24** [11], 342–43 (1928).—The opening meeting of the Fourth Session of the Electroplaters' and Depositors' Technical Society took place Oct. 10 at Northampton Polytechnic Institute. The meeting was devoted to the reading and discussion of a paper by L. Wright on "Polishing Compositions for the Electroplating Industry." The finish required on a metal surface is a function of the coarseness of the abrasive and the peripheral speed of the mop. The coarser the abrasive and the faster the wheel the deeper the cut. It will be found that an average speed of 6500 ft. per minute is most suitable for cutting down and a speed of 10,000 ft. per minute is suitable for final coloring. E.P.R.

New tool material cuts steel, metals, glass, bakelite. ANON. *Brass World and Platers' Guide*, **24** [12], 367–68 (1928).—The research laboratory of the General Electric Co., Schenectady, N. Y., has developed a new material for machine tools. This material, called "Carboloy," has been placed on the market by the Carboloy Co., Inc., New York City, which was formed to market the new material, said to be the hardest known cutting substance. E.P.R.

Portable buffing and grinding machine. ANON. *Brass World and Platers' Guide*, **24** [12], 376 (1928).—The Hisey-Wolf Machine Co., Cincinnati, O., has placed on the market a new type of portable grinder and buffer which is electrically operated, with ball bearing motor and roller bearing spindle. The features are outlined. E.P.R.

Natural abrasives, 1927. ANON. *Can. Chem. Met.*, **12** [12], 38 (1928).—In the final statistical report of the Dominion Government on this field, the capital employed by the nine producing firms is given as $433,810 for 1927. Of corundum, which is found in Renfrew and Hastings counties, Ont., no shipments are reported since 1921. The production of diatomite, or tripolite, which is a siliceous material closely related to quartz, amounted to 266 T. valued at $6650 in 1927, and was obtained from a deposit at East New Annan, N. S. Several years ago, a deposit of garnets in Ashby township, Ont., was actively developed, but since 1924 no shipments have been made. A deposit in Joly township, Quebec, is now being worked and during the past year 2 T. worth $150 were shipped. Production of grindstones, pulpstones, and scythestones in Canada during 1927 amounted to 2251 T. valued at $125,017, as compared with 2695 T. worth $151,227 in 1926. Of this total 1860 T. were from New Brunswick, 380 T. from B. C., and 11 from N. S. Volcanic dust to the value of $735, representing the 105 T. from deposits near Weldeck, Sask., was shipped last year. As well as natural abrasives, artificial abrasives, such as fused alumina, crude silicon carbide, fire-sand, etc., valued at $6,106,784 were produced in Canada. E.J.V.

The structure of β-corundum. C. GOTTFRIED. *Fortschritte Mineral. Kryst. Petrog.*, **12**, 34–35 (1928).— A preliminary examination by X-rays of β-corundum gave n 1.68, d. 3.30, and O atomic volume 17.25 cubic A. U. as against 1.768 and 14.05 for α-corundum, pointing to a closely packed arrangement for the latter and an open structure for the β-modification. The Laue diagram shows a hexagonal axis with 6 planes of symmetry. The unit cell has the dimensions $a = 5.63$, $c = 22.63$ A. U. ($c/a = 4.02$) and contains 12 mols of Al_2O_3. (*C.A.*)

Etch and solution figures on corundum. M. SEEBACH. *Neues Jahrb. Min. Abt. A, Beil.-Bd.*, **54**, 420–43 (1926).—Artificial corundum (polished spheres) was etched in fused $KHSO_4$ for different lengths of time. The indices of the solution forms are compared with those of the growth forms. (*C.A.*)

PATENTS

Grinding machine. PRENTICE CONRADSON. U. S. 1,695,759, Dec. 18, 1928. A machine of the character described having, in combination, a base, a carriage mounted

for reciprocation on it, a rotary spindle in the carriage, the carriage having a depending bracket extending into the base, a piston and cylinder unit having one element supported by the bracket and having the other element solidly mounted on the base, a motor mounted on the under side of the bracket below the piston and cylinder unit, and means for supplying fluid to the cylinder and exhausting it therefrom to effect reciprocation of the carriage.

Machine for grinding or cutting stone. JULIUS WEGNER. U. S. 1,696,660, Dec. 25, 1928. In a machine for grinding flat stone horizontally or fluting columns vertically, the combination of a table upon which the stone or column is supported, a rotary grinding head, a shaft carrying the grinding head, a carriage, means for transversely pivoting the shaft intermediate its ends to the carriage, so that the shaft may swing in a plane transverse to the table, from a vertical to a horizontal position, an electric motor carried by the pivoting means for driving the grinder shaft, a crossrail supporting the carriage, extending across the table, a vertical screw for raising and lowering the crossrail, power operated means for rotating the vertical screw, so as to feed the grinder vertically when the grinder shaft is in horizontal position when fluting columns, a screw for adjusting the carriage along the crossrail, across the work, and for holding the carriage in its adjusted position, and means independent of the electric motor for reciprocating the stone supporting table beneath the crossrail, at right angles to the plane.

Method of cutting bevel gears. ERNEST WILDHABER. U. S. 1,696,930, Jan. 1, 1929. The method of producing a bevel gear which consists on cutting its side tooth surfaces, two sides simultaneously, by moving a pair of cutting edges across the face of a tapered gear blank, while imparting a relative rolling motion between the cutting edges and blank in which the blank rolls with a cone surface of smaller dimension than its pitch cone surface on the pitch surface of a basic gear represented by the cutting edges, thereby to reduce the amount of roll required to generate the tooth profiles.

Sanding wheel. JAMES F. WEBBER. U. S. 1,697,442, Jan. 1, 1929. A sanding wheel of laminated character comprising in combination a collection of individual strips of fibrous material, each coated on its opposite sides with an abradant, and an adhesive bonding together adjacent abradant-coated portions of the collection of strips to form a composite hub for the wheel with other free abradant-coated portions of the strips extending from the hub.

Sectional grinding wheel. ELWIN R. HYDE. U. S. 1,697,505, Jan. 1, 1929. A grinding wheel comprising a support, a plurality of grinding blocks having convex outer ends forming the periphery of the wheel, and means for clamping the blocks against one side of the support, comprising a plurality of separate plates all arranged in a common plane to directly engage one side of the blocks and means for clamping the blocks between the support and the plates in a direction axially of the wheel, there being independent clamping means for the individual plates so that a plate and a block held thereby may be removed independently of the other plates and blocks, and coacting means carried by the blocks and their mounting means to prevent radial displacement of the blocks.

Work holder for cylinder-grinding machines. JOHN J. SCHMIDT AND ULRICH STEINER. U. S. 1,697,782, Jan. 1, 1929. In a cylinder grinder, a table, a work holder pivoted at one end thereon having upstanding arms, means on the other end of the work holder for vertically adjusting it relatively to the table, bars vertically adjustable on the arms for carrying a cylinder block, and a gage for determining the position of the block.

Grinding attachment. GEORGE S. KLEIN. U. S. 1,698,336, Jan. 8, 1929. A blade supporting device for blade grinding machines including an open collar, an arm extending at an oblique angle with respect to the collar and forming a part of the collar, means for securing the collar to the grinding machine, an offset portion forming a part of the arm,

and adapted to rest in spaced relation with the grinding wheel forming a part of the grinding machine, the offset portion having an opening formed adjacent to its end to receive a blade of a star-shaped cutter supported by the supporting device, and an upstanding flange formed at the end of the offset portion.

Abrasive wheel. HENRY K. SPENCER. U. S. 1,698,685, Jan. 8, 1929. In an abrasive wheel, the combination of a series of blocks of abrasive material, and a holder therefor comprising a series of yokes each spanning two blocks, and a series of clamping bolts pivotally connected to the yokes, respectively, and arranged to permit the yokes to rock toward and from the blocks to cause them to exert clamping pressure on the blocks.

Spindles and spindle-mountings. PRESSLUFTWERKZEUG UND MASCHINENBAU AKT.-GES. PREMAG. Brit. 298,487, Dec. 5, 1928. Resilient mounting for the spindle of a grinding or polishing disk consists of a head carrying in ball bearings a driving spindle coupled by a universal joint or flexible shaft, etc., to a part of the spindle which carries the disk.

Grinding horn cheeks of locomotives, etc. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 299,252, Dec. 19, 1928. A machine for grinding the surfaces of the horn cheeks of locomotives, etc., consists of a column, mounted on cross slides and having pivoted thereon a beam carrying at one end a spindle having thereon two opposed grinding rings driven by an electric motor at the other end of the beam, and gearing. The beam is oscillated up and down by means of a rod actuated by a piston in a cylinder to which fluid is fed by a pump, the column serving as a reservoir for the fluid. Valves and tappet gearing are provided, together with means for varying the amplitude of oscillation of the beam. By adjustment of the machine the flat faces and the edges of the horn cheeks may be ground.

Grinding and other machine tool frames and tables. C. KRUG. Brit. 299,437, Dec. 19, 1928. The main elements of machine tools, such as the frames, headstocks, and sliding tables are built up from sheets, bars, angles, and like structural ironwork connected by bolting and welding, bolting being employed when adjustment during or after erection is necessary. The invention is described with reference to grinding-machines.

Grinding wheel spindles and spindle mountings. F. W. LANCHESTER. Brit. 299,552, Dec. 19, 1928. The spindle of a grinding machine is supported in a bush by means of a cage carrying balls, so arranged that no two balls travel in the same track. The spindle and the cage are tapered, adjustment for wear being provided by washers, and the spindle being held in position by a screwed driving pulley and a nut. The grinding wheel carrier is held in a tapered hole in the spindle by an axial stud and a nut.

Grinding wheels. BIRMINGHAM SMALL ARMS CO., LTD., A. R. PAGE, AND P. S. DEVEREUX. Brit. 299,633, Dec. 28, 1928. In a grinding wheel of the type in which a number of abrasive segments are clamped around a central rotary member, the interstices between the segments are filled by a plastic filler which sets, without the application of heat, to form a material approximating to that of the grinding segments. A magnesium cement consisting of 60 g. of calcined magnesium oxide mixed with 60 to 90 cc. of saturated solution of magnesium chloride may be employed, and one part of this cement is mixed with 2 parts by weight of abrasive grit to form a paste which is applied to the surfaces to be joined.

Grinding twist drills. T. A. JACKSON AND W. J. SKELLY. Brit. 299,640, Dec. 28, 1928. In a machine for grinding twist drills, the drill is mounted in fixed axial relation to a rotary grinding wheel mounted in a head having a planetary movement around the drill which is fed axially toward the head.

Grinding externally and internally. CINCINNATI GRINDERS, INC. Brit. 299,799, Dec. 28, 1928. A centerless grinding machine for grinding simultaneously the exterior and interior surfaces of tubular articles consists of a grinding wheel rotatably mounted on a bed, a regulating-wheel movable with a slide toward and from the wheel, an internal grinding wheel, and a work-rest carried by the slide. The slide is moved up to the wheel to reduce the work to size externally, by a cam driven by a motor and adapted to oscillate a lever engaging a screw adjustable by hand to position the regulating wheel to suit the diameter of the work and to compensate for wear of the wheel and on completion of grinding the slide is retracted to allow of ejection of the work by an ejector actuated by a ratchet wheel which is rotated through rack and pinion and ratchet and pawl gearing by the reciprocation of the slide. The internal grinding wheel is mounted on a slide movable by a cam and a lever engaging a screw adjustable by hand in the slide the cam being rotated through bevel gearing and a telescopic shaft from the motor; the wheel is driven by a motor.

Art

Some leadless borosilicate glazes containing nickel oxide. H. H. HOLSCHER. *Jour. Amer. Ceram. Soc.*, **12** [2], 111–17 (1929).—The literature pertaining to the use of nickel oxide in all types of glazes is briefly reviewed. A study of the effect of the various glaze constituents on the color and other properties of some leadless borosilicate glazes containing nickel oxide as a colorant is reviewed. Nickel oxide has not proved useful in glossy non-opaque glazes. It is not recommended for use where a deep (dark) color is desired but can be made to produce very pretty opaque glazes, light tan in color and of a semimat character.

Beautifying glass. H. S. NASH. *Bull. Amer. Ceram. Soc.*, **8** [1], 1–7(1929).—Industry is coming more and more to realize the importance of beauty as a selling factor. The three basic elements in glassware design are the nature of the material, the use of the object, and the limitations of the method of manufacture. Beauty in the useful arts is considered to be the ability of the object to express charmingly and within the inherent limitations of its material a character in fine accord with the purpose for which the object is intended. Art applied to glassware may give an inanimate object a personality and may cause it to express such very definite traits as generosity, sympathy, boldness, honesty, reticence, strength, dignity, and elusiveness. Some comments on the present state of glassware design in the U. S. are offered. The industry must work together as an association for its common good in order to accomplish anything. A new style based on sound artistic principles among which imitation has no standing could be dictated by illuminating glassware manufacturers if they worked as a unit. There is no branch of the glass industry to which art offers a greater opportunity than that of the glass container. The design of glass containers is no simple matter to be left to mediocre designers, but is an art worthy of the finest talent. Suggestions for beautifying glassware are offered. E.J.V.

What I look for as a consumer of ceramics. EVELYN T. OPENHYM. *Bull. Amer. Ceram. Soc.*, **8** [1], 8–10 (1929).—In other fields of endeavor it is being discovered that mechanical perfection cannot be monopolized, and that in order to compete successfully it is necessary to use good form and color, two essential aspects of beauty. The ceramist is also finding that the products he manufactures must meet the demand of the purchasing householder, his greatest client, and has found that an article may be beautiful as well as useful. Examples of what is being done in the introduction of both beauty and usefulness into ware are given. Beauty is wanted, but in relation to our present-day needs. E.J.V.

Color facts. ANON. *Glass Ind.*, **10** [1], 14 (1929); reprinted from *Color-Craft.*—Hue is the identification of a color. When you change red to red-orange, you have

changed the hue. A shade is any tone deeper and a tint a tone lighter than the normal or spectrum tone of a color. Value is the term used to designate the light or dark quality of a color. A shade is a dark value and a tint is a light value. A neutralized color is a grayed color. The intensity of a color refers to its brilliancy. As a color becomes neutralized, it loses its intensity. E.J.V.

Glass craft sculpture. ANON. *Glass Ind.*, **10** [1], 17 (1929).—Modernistic designs executed in glass by a new bold relief process said to be of French origin, simulating carving and affording bas-relief reproductions of birds, flowers, airplanes, dolphins, sea nymphs, birds of rare and gay plumage, animals, reptiles, and other objects in plain glass and colors with lighting variations have been installed in the new Paramount Theater, Brooklyn, N. Y., by the Eny Art Corp. of N. Y. Interior decorations are of curved glass, decorated by the new process, in plate of various thicknesses up to 1 in. This so-called "glass craft sculpture" so far has been principally embodied in broad designs which stand out from the background very effectively because of the deep cutting, but it is also employed in more delicate designs for numerous purposes. Many of the new styles are by Parisian designers. Some of the pieces in the Brooklyn theater are of curved glass set in niches more than a foot deep. The polyform facets flash brilliantly when illuminated and produce remarkable effects. As a result, the atmosphere of richness and luxury is greatly enhanced. Products made by the new process have also been applied to various other uses. It is used successfully for decorating objects of art, such as glass vases, bowls, etc. E.J.V.

Byzantine and Venetian glass. WALTER BUTTERWORTH. *Pottery Gaz.*, **54** [619], 92–97 (1929).—Outstanding periods in production of artistic glass were Egyptian, Roman, Byzantine and Saracenic, Venetian, German, French, and Modern, in which English flint glass plays an important part. Of these, probably the most brilliant was the Venetian, which is discussed with some reference to the Byzantine and Saracenic glass which preceded it. For some centuries Venice held acknowledged pride of place in the production of many forms of glass, generally with a strong impress of grace and style. The Venetians were not distinguished for invention in glass, but they had development, application, and resourcefulness. From Egypt, Rome, Constantinople, and Damascus, she drew much of her knowledge and experience. Beads, jewelry, goblets, mosaics, ceremonial glasses, lamps, and mirrors had been made centuries before, sometimes even thousands of years earlier. The Byzantine Empire lasted from the year 330 until 1453. Glass mosaics were used in the building of mosques, churches, and palaces. Many magnificent mosques and churches are still in existence in Constantinople, Jerusalem, Damascus, Italy, Sicily, and almost innumerable places in the East and around the Mediterranean, where the beautiful interiors, lined with colored glass, glowed with reflected lights, continually changing with time and the variations of weather. Few undoubted examples of Byzantine hollow-ware glass have survived, especially of the earlier period. When the Crusaders took Constantinople in 1204 they plundered it of much fine glass. The largest collection of these treasures was preserved at San Marco, Venice, and in museums of Europe. They consist of chalices, cups, bowls, vases, dishes, basins, and lamps, all of a ceremonial kind. Perhaps the most noteworthy idea at this time was decoration upon the glass by enamel painting, apparently begun by Greeks under Byzantine rule. Saracen glass coins and weights in colored glass (mostly green) were stamped with the names of caliphs from 720 to 1225. Glass factories of Damascus were famous and this fame continued until the 14th Century. During the Saracenic sway glass objects of beauty were produced, especially from the 13th to 16th centuries, the period when Venice superseded all other countries in the craft. These Saracenic vessels, especially lamps for the mosques, were decorated with enamel paintings of gold, red, blue, and other colors, including black and white. Fine lamps were made in Mesopo-

tamia and Syria, and sent to Egypt. In the 15th Century the art declined and Venice took it up in changed form. Enameling on glass was an important advance. The glassworks of Venice were so numerous and busy by 1292 that the council ordered their removal to the neighboring island of Murano. The Guild of Glassblowers had been formed and records exist of public processions in which fine glasses were displayed by artisans. Workshop regulations were stringent. Beads were frequently articles of value and beauty. Some were of mosaic or opaque colors in patterns going through the beads. In 1318 pearls were imitated, following nature's irregularities and brilliancy. These and prayer beads for rosaries formed more employment for the lampblowers. Glass lenses for spectacles followed the use of rock crystal lenses. Mirrors grew into importance in Venetian glassmaking. Dante made interesting reference to them in 1317, when the idea occurred of backing glass sheets with an amalgam of tin and quicksilver. An elaborate type of mirror was presented in 1660 to Marie de Medicis, described as a blaze of rock crystal and gold, agate, diamonds, emeralds, cameos in hyacinth and gold, valued at $30,000 in 1791. Venetian glass reached its zenith in the 15th and 16th Centuries. Venetians were skilled in the manipulation of rods or tubes, colorless and colored, twisted and arranged in many different ways, forming filigree and latticinio, and imitating jewels. E.J.V.

Accurate determination of color by new instrument. ARTHUR C. HARDY. *Amer. Glass Rev.*, **48** [12], 15 (1928); for abstract see *Ceram Abs.*, **8** [2], 88 (1929).

Glass lighting fixtures. ANON. *Ceram. Ind.*, **12** [1], 35 (1929).—Modern glass lamps for the home are illustrated. F.P.H.

Modern creations of ceramic ware. ANON. *Ceram. Ind.*, **12** [1], 52–53 (1929).—The newest creations in ceramic ware both American and foreign are illustrated. F.P.H.

Newark Museum shows ancient glassware. ANON. *Ceram. Age*, **12** [2], 60–61 (1928).—A description is given of a recent exhibit of ancient Egyptian, Graeco-Roman, Saracenic, and Sidonian glass. The specimens dated from the 4th Century B.C. to about 400 A.D. A.E.R.W.

Blue dash chargers and origin of their designs. EDWARD A. DOWNMAN. *Connoisseur*, **32** [328], 220–25 (1928).—The history of designs of blue dash chargers is traced on samples examined at the British museum. Illustrated. T.W.G.

Modern art. C. G. HICKS. *Crockery and Glass Jour.*, **106** [18], 92 (1928).—The interest being shown by the buying public in modernistic china and glass creations suggests that the buyer meet the growing demand with stock and advertisements that reflect the modern note. H. describes and distinguishes between modernistic, ultra-modernistic, and futuristic designs on pottery and glassware. See "America Demanding Art in Industry," *Ceram. Abs.*, **7** [8], 510 (1928). E.P.R.

Old Waller ware. C. G. HICKS. *Crockery and Glass Jour.*, **106** [18], 105 (1928).—Old Waller ware is a historic semiporcelain contemporaneous with the great productions of the late 18th Century. It is made exactly as it has been during the last 150 years, with the same molds and the same patterns. The ancient monastic group that gave it to the world was first established in an old monastery dating back to the 10th Century. The history of the developments of dinner ware in general and old Waller ware in particular is given. E.P.R.

Piracy of design. C. H. GERARD. *Crockery and Glass Jour.*, **106** [18], 93 (1928).—G. treats of the harm done to a high grade article by copying and cheapening its design. E.P.R.

Rebirth of Czecho peasant art. BEATRICE MILLER WISNER. *Crockery and Glass Jour.*, **106** [18], 111 (1928).—An enduring tribute to Joseph Mrazek, leader artist of a

group of peasants of the colony of Letovice, Czechoslovakia, is the return of an art long held captive by Austrian rule. E.P.R.

Ceramic industries in Valencia, Spain. CLEMENT E. EDWARDS. *Crockery and Glass Jour.*, **106** [18], 120 (1928).—One of the most important industries of Valencia is the manufacture of tile (azulejos) and the production of ceramics of an almost endless variety. The local production of pottery is centered in the town of Manises, a few miles from Valencia, and the industry dates back to the Middle Ages and the beginning of the Renaissance. More than 100 factories are engaged in the manufacture of tile and general ceramics. Nearly every article that may be made of clay is produced in these factories. The manufacture of tile, for which there is a heavy domestic demand, is carried on to a large extent, and the product ranges from the ordinary cheap tile to one that is richly ornamented and artistically decorated. Chinaware of various grades, earthenware, and majolica ware are produced in large quantities and the famous metallic-luster ware, for which there appears to be an increasing demand, is turned out in considerable quantities. The design or figures on the ordinary tile is applied by stenciling. The decoration of the majolica ware and other dishes is, however, a work of art. The country in the immediate vicinity of Manises supplies the greater part of the clay used in the industry, although some is obtained from other parts of the peninsula. The clays employed in the mixture of what is called "pasta negra," and which serves for the manufacture of all ordinary earthenware such as jars, ewers, flower pots, and basins, are known as "Tierre de cantaro" and "Tierra del Llano de Cuarte" and are found in the region. The clays and material which enter into the composition of the "pasta blanca" or white mixture, from which the finer china and majolica ware and all of the other finer products are made, are "caolin" (kaolin), "arcilla" (white clay, commonly known as potter's clay), "feldespate" (feldspar), and "greta." All of these are also found in abundant quantities in the immediate neighborhood. The colors employed in the ornamentation of the various products are produced by the manufacturers themselves, each using his own formula. Natural mineral coloring materials used (ochre and the like) are products which the district itself yields, the Province of Alicante chiefly. Some of the materials are imported. Between 60 or 70% of the total production of ceramics is disposed of in the local and domestic markets. The remainder goes into export. E.P.R.

Designers in the ceramic industry. ARTHUR THEODORE FINCH. *Crockery and Glass Jour.*, **106** [18], 128 (1928).—The relationship between the designer and the manufacturer is discussed in some detail. E.P.R.

Machine draws two sheets of glass at one time. ANON. *Nat. Glass Budget*, **44** [31], 5 (1928).—A new type of machine is designed to draw two sheets of glass vertically at one time where it is only possible to draw one by any other method. The Modern Glass Co., Inc., with factory at Bridgeton, N. J., will operate the new machine. The new method employs the LeRoy patent. It is so constructed that it also anneals and polishes the glass during the process of drawing and leaves the product with a beautiful finish. E.P.R.

Artistic pottery and glass. ANON. *Pottery, Glass, and Brass Salesman*, **38** [12], 17 (1928).—The article lists and describes new and attractive merchandise of pottery and glassware shown by importers and retailers. E.P.R.

Chinese tea-bowls. C. T. CURRELLY. *Toronto Mail and Empire*, Dec. 27, 1928.—The Royal Ontario Museum has acquired tea-bowls of Chien ware, the type which became famous for retaining the color of tea after more brewings than any other ware. Japan adopted the tea ceremony and imported Chien ware. The bowls became of great value and were commonly buried with their owner. When the building of railways caused many tombs to be opened, a number of the original Chien bowls, 1000 years old, were found and have been obtained by the Museum. H.H.S.

BOOKS

Chinese Porcelain and Wedgwood Pottery. R. L. HOBSON. Vol. II of the Leverhulme Art Monographs. B. T. Batsford, London, 1928. Price for 3 vols., 15 guineas. Illustrated by 346 full page plates in color, photogravure, or monochrome. The edition is limited to 200 sets. The first volume is on English painting by R. R. TATLOCK, and the third, on English furniture, tapestry, and needlework, by PERCY MACQUOID. H.H.S.

English Glass Pictures, 1690–1810. H. G. CLARKE. Pp. xix + 107; 94 plates. Courier Press, London, 1928. Price 72*s*, 6*d*.—Glass pictures are of two kinds; those which are direct paintings on glass, and those which are produced by transferring an engraved print to a glass surface and painting it over in color. It is evident that the interest of such pictures lies in the picture rather than in the glass, but recent sale prices show that these decorative wares are growing in value. Reviewed in *Times Lit. Suppl.*, Nov. 22, 1928. H.H.S.

Art in the Life of Mankind. ALLAN W. SEABY. Two volumes. B. T. Batsford, London, 1928. Price each vol., 5*s*.—The first volume is a general view of art; the second deals with art in ancient times—prehistoric, Sumerian, Egyptian, Babylonian, Assyrian. H.H.S.

Roman London. Royal Commission on Historical Monuments. 150 illustrations. H. M. Stationery Office, London, 1928. Price 18*s*.—The third volume of the inventory of historical monuments in London is a fully illustrated survey of the Roman City of Londinium. The pottery found fails to prove the existence of a British pre-Roman London. Reviewed in *Times Lit. Suppl.*, Nov. 22, 1928. H.H.S.

Practical Color Simplified. W. J. MISKELLA. Finishing Research Laboratories, Chicago. Reviewed in *Min. and Met.*, **10** [265], 47 (1929); see *Ceram. Abs.*, **7** [11], 795 (1928). F.P.H.

PATENTS

Ornamental design for goblet. GEORGE DOUGHERTY. U. S. 77,227, Dec. 18, 1928.

Ornamental design for tumbler. EDWARD E. BARTLETT. U. S. 77,281, Dec. 25, 1928.

Ornamental design for goblet. EDWIN E. SLICK. U. S. 77,332, Dec. 25, 1928.

Ornamental design for goblet. CHARLES R. KEIL. U. S. 77,362, Jan. 1, 1929.

Ornamental design for plate. CHARLES WEISS. U. S. 77,341, Dec. 25, 1928.

Ornamental design for plate or similar article. CHARLES WEISS. U. S. 77,381, Jan. 1, 1929.

Ornamental design for plate or similar article. CHARLES WEISS. U. S. 77,382, Jan. 1, 1929.

Ornamental design for plate or similar article. RICHARD R. J. COPELAND. U. S. 77,396, Jan. 8, 1929.

Ornamental design for plate or similar article. CHARLES WEISS. U. S. 77,445, Jan. 8, 1929.

Ornamental design for light fixture. HERBERT M. FIRTH. U. S. 77,314, Dec. 25, 1928.

Ornamental design for light shade. NICHOLAS KOPP. U. S. 77,319, Dec. 25, 1928.

Ornamental design for light shade. NICHOLAS KOPP. U. S. 77,320, Dec. 25, 1928.

Ornamental design for bath-room fixture. PAUL G. DURYEA. U. S. 77,228, Dec. 18, 1928.

Ornamental design for faucet. WILLIAM O. THOMPSON. U. S. 77,334, Dec. 25, 1928.

Ornamental design for faucet. WILLIAM O. THOMPSON. U. S. 77,377, Jan. 1, 1929.

Ornamental design for faucet. SHERMAN SMITH. U. S. 77,373, Jan. 1, 1929.

Coating glass articles. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 299,477, Dec. 19, 1928. Electric lamps, and other glass articles which are heated in use, are coated with a mixture comprising castor oil, a resinous substance, and a pigment. Examples are given of the use of pigments of various colors with a solution of shellac in alcohol and castor oil. The coating is produced by drying, preferably at high temperatures such as 160°C, whereby reaction between the resinous substance and castor oil probably occurs.

Cement, Lime, and Plaster

Gypsum and anhydrite in the manufacture of Portland cement. II. RICHARD K. MEADE. *Rock Prod.*, **31** [25], 40–45 (1928).—M. gives the following general conclusions relating to the effect of gypsum and anhydrite on Portland cement: (1) anhydrite-gypsum mixtures of present commercial or any probable future commercial anhydrite content are effective and safe retarders for Portland cement; (2) the SO_3 content of the anhydrite in such mixtures is as effective as the SO_3 content of the gypsum; (3) the effect of these mixtures on retardation is just as good as of pure gypsum, per unit of SO_3 added; (4) their effect on the strength of the cement is no greater or no less than pure cement, per unit of SO_3 added; (5) pure anhydrite is in itself a retarder for cement, even under laboratory conditions; (6) anhydrite is decidedly not an injurious impurity, nor is it an inert adulteration in gypsum for cement retardation. F.P.H.

Effect of retarders of Portland cement clinkers. ERNEST E. BERGER. *Rock Prod.*, **31** [25], 50–51 (1928).—B. gives a thorough discussion of retarding Portland cement with anhydrite and plaster of Paris. F.P.H.

Bureau of Standards investigations on cement, lime, gypsum, and stone. ANON. *Rock Prod.*, **31** [26], 147–51 (1928).—Progress is reported on the following problems now being investigated at the Bureau of Standards: (1) study of the reaction of water on the calcium aluminates, (2) constitution of Portland cement, (3) expansion and contraction of Portland cement mortars, (4) workability of cements, (5) heat of reaction of Portland cement and water, (6) improvement of hydrated lime, (7) properties of chemical limes, (8) adhesion of plaster to hollow clay tile, (9) development of sound-absorbing plaster, (10) adhesion of mortar to sand-lime brick, (11) rate of drying of wall plaster, (12) plastic caulking and pointing materials for masonry, (13) temperature measurements in limestone masonry. F.P.H.

Progress in foreign research and technology of rock products in 1928. ANON. *Rock Prod.*, **31** [26], 220–23 (1928).—This article gives a summary of abstracts and scientific papers on rock products published during the year. F.P.H.

Operating data on four cement kilns. ANON. *Tonind. Ztg.*, **52** [42], 850–52(1928); *Rock Prod.*, **32** [1], 78 (1929).—The kiln committee of the Association of German Cement Mfrs. has tested four more kilns since early in 1927. F.P.H.

Behavior of trass cement in corrosive water. H. BACH. *Tonind. Ztg.*, **52** [52], 1058–60 (1928); *Rock Prod.*, **31** [25], 62 (1928).—When added to Portland cement in preparing mortar for concrete construction in damp ground, trass sets chemically the lime liberated in the setting of the mortar, in conjunction with the solidifying of the mortar by the addition of trass. This has made the cement-trass concrete widely acceptable where corrosive waters are likely to be encountered. Since the trass must be carefully admixed to the Portland cement in the correct proportions, which is carried out with difficulty at construction sites, users of cement have expressed a desire for ready-mixed trass cement. As a result the cement works Oberkassel of the Bonner Bergwerks- und Huettenverein delivered first in September, 1924, a trass cement which contained the following primary constituents in percentages by weight: moisture 1.10; hydrate water 2.59; CO_2 1.35; acid insoluble 6.84; soluble silicic acid (SiO_2) 23.23; sesquioxide

(Fe_2O_3 + Al_2O_3) 11.92; lime 48.02; magnesia 2.99; phosphoric acid 0.40; sulphuric acid 1.70. The various standard volume-consistency tests were also met satisfactorily by the trass cement. The mortar of trass cement and standard sand showed after 28 days higher strength values than mortar of trass, cement, and standard sand. In February, 1925, 100 samples for testing tensile strength and of a proportion of 1 trass cement to 3 standard cement were placed in a 2½% magnesium sulphate solution, 50 of them fully and 50 only one-half immersed. The liquid level was maintained by a weekly addition of distilled water. Tests were then made for tensile strength after 1-, 1½-, 2-, 2½-, and 3-year storage periods. All fully immersed samples were in good condition after each observation period (February, 1925, to February, 1928). The partly immersed samples showed no deterioration after 1½ years, but after 2 years there were changes in the surface of the halves exposed to the room air, which were considerable after 2½ years, while the hardening process continued at the core. After 2½ years only 19 fully immersed test samples remained, which were then raised one-half way out of the solution; after the 3-year period the edges thus exposed to room air showed also more or less deterioration. F.P.H.

Dutch cement standards. ANON. *Tonind. Ztg.*, **52** [54], 1102–1103 (1928); *Rock Prod.*, **31** [25], 62 (1928).—The Associated Cement Plants of Holland established new standards valid until December 31, 1928, which, although not yet recognized by the standardization commission, have found acceptance by the German, Belgian, and British cement industry. Accordingly, Portland cement should have not less than 1.7 parts by weight of lime to 1 part of soluble silicic acid (SiO_2), plus argillaceous earth (Al_2O_3), plus iron oxide (Fe_2O_3); iron Portland cement should have at least 70 parts by weight of Portland cement clinker and the balance should be granulated, basic, blast-furnace slag of the composition: $\frac{\text{CaO plus MgO}}{\text{SiO}_2 \text{ plus } \text{Al}_2\text{O}_3} > 1$; blast-furnace cement should consist of 15 to 69 parts by weight of Portland cement clinker, and of granulated basic blast-furnace slag of the composition: $\frac{\text{CaO plus MgO plus } \frac{1}{2}\text{ Al}_2\text{O}_3}{\text{SiO}_2 \text{ plus } \frac{2}{3}\text{ Al}_2\text{O}_3} > 1$ with a maximum content of 5% MgO. Based upon the weight of test samples dried for 90 min. at 212°F, the maximum content of particles insoluble in silicic acid should be 3% for every cement, the maximum content of magnesia should be 5% in Portland cement and none in the iron Portland cement and blast-furnace cements; and that of sulphuric acid anhydride 2½% in Portland cement and none in the others. A pot of pure cement and water should not start to set before one hour after preparation. The maximum residue of the test samples from the three cements, heated for 90 min. at 212°F, should be 2% in weight on the 900 mm. (75-mesh) screen and 20% on the 4900 mm. (175-mesh) screen except for blast-furnace cement where it should be 12%. The minimum strength of mortar test samples from these three cements, prepared of 1 part by weight of cement to 3 parts of German standard sand, should be: for 1 day storage in damp air and then 2 days under water (327 lbs. per sq. in. tensile and 3555.9 lbs. per sq. in. compressive strength in class B), which class is cement of high initial strength; for 1 day storage in damp air and then 6 days under water 256 lbs. tensile and 2844 lbs. compressive strength in class A, which class is ordinary cement (369.8 lbs. tensile and 4978.2 lbs. compressive strength in class B), and for 1 day storage in damp air and then 27 days under water 369.8 lbs. tensile and 4267.0 lbs. compressive strength in class A (455 lbs. tensile and 6044.99 lbs. compressive strength in class B), the temperature of the air and water remaining constant between 59°F. and 64.4°F. F.P.H.

Waste heat equipment for Portland cement mills. L. ECK. *Pit and Quarry*, **17** [7], 59–63 (1929).—The Marguerre waste heat equipment possesses great flexibility and requires but a small amount of space for installation. Kraftanlagen-Aktiengesell-

schaft of Dressau holds the construction rights for this process. The Marguerre process of waste heat utilization is based upon the use of water as a circulating medium. The water is compressed by a pump, heated in a heating body system, and partially evaporated by expansion below its saturation temperature. The non-evaporated water flows back to the pump and again enters the circuit. The amount of transformed water is regulated automatically. R.G.E.

Physical properties of cast stone. ANON. *Pit and Quarry*, **17** [7], 75 (1929).—A total of 44 samples of cast stone made by 21 manufacturers in the U. S. have been collected in the study of the properties of this material which is being made as a basis for the preparation of a federal specification. The range of values obtained so far is as follows:

	Maximum	Minimum
Compressive strength, lb./sq. in. of 2 x 2-in. cylinders	10,300	2,370
Modulus of rupture, 1 x 1-in. bars on 6-in. span	1,575	375
Absorption, 48 hrs. in water at 21°C by weight (%)	10.8	3.3
Absorption, same as above followed by 5 hrs.' boiling (%)	14.6	7.3
Porosity, per cent by volume	33.8	16.0
Secant modulus of elasticity at 50% compressive load (lb./sq. in.)	3,300,000	1,400,000
Cycles of freezing and thawing to cause failure	380	62

A group of 500 test cylinders of concrete containing large size crushed stone as the large aggregate and screenings from crushing the stone as fine aggregate were tested in compression at the approximate age of 3 months. The cylinders varied from 2 to 36 in. in diameter and the height was equal to twice the diameter. The largest size aggregate present in the 36-in. cylinders varied from $^3/_8$ in. to 10 in. As the cylinder diameter was decreased the largest size aggregate present was reduced. Another group of cylinders, including specimens of every size, was made in the proportion of 1 part cement to 2.7 parts aggregate, all aggregate having been smaller than the $^3/_8$-in. sieve. In this group, the 36-in. developed an average compressive strength of 2550, the 12-, 18-, and 24-in. specimens 3000, the 6- and 8-in. specimens 4100, and the 2- and 3-in. specimens approximately 5100 lbs. per sq. in. In the other groups of cylinders, the 36-in. cylinder contained aggregate of maximum size varying from $2^1/_2$ to 10 in., proportions being approximately 1:3:3, 1:3:4, and 1:3:4.6. Before filling the 8-in. molds, all aggregate above $2^1/_2$-in. was removed from the concrete, for the 6-in. molds all over $1^1/_2$-in., and for the 2- and 3-in. molds all over $^3/_8$-in. The strength of the 36-in. diameter cylinders varied from 1500 to 3100 lbs. per sq. in., compared with the minimum and maximum average strength of 2260 and 4400 for the 8-in., and 3130 and 4700 for the 6-in. cylinders. There was a general tendency for the smaller specimens to give higher strengths. Stress-strain readings were taken on the 18- and 36-in. diameter cylinders, readings being taken without stopping the application of load. The ultimate strains varied from 0.0015 to 0.0032 in. per in. and the initial modulus of elasticity varied from 2,200,000 to 3,600,000 lbs. per sq. in. In all cases the average modulus for the 36-in. cylinders was higher than for the 18-in. cylinders. The rate of deformation of the cylinders tested is very slow at first, gradually increasing in value, becoming practically constant and remaining so throughout the greater part of the test. R.G.E.

Asbestos cement. ANON. *Pit and Quarry*, **17** [7], 76–77 (1929).—Asbestos cement is made from asbestos and Portland cement and is really reinforced concrete with the asbestos fiber replacing the steel. Because of its flexibility and fineness, the asbestos fibers need be covered only to the extent of a few tenths of an inch, and very thin layers of the finished product obtained. Asbestos cement is extremely resistant to chemical

attack. Acids have little effect due to the formation of free silica which protects the product from further action. Alkalis and neutral salts have no action on the material. As the product contains no organic matter it is entirely immune to rot or attack by micro-organisms. It is impermeable to water, has a very low thermal conductivity and is a nonconductor of electricity. It is successfully used for interior and exterior walls, as a facing and in sheets as a ceiling or roof. Roofs made of this product are preferred by many chemical works. R.G.E.

Action of gypsum on cements. H. LAFUMA. *Pit and Quarry*, **17** [7], 78 (1929).—The action of calcium sulphate in solution and of sea water on Portland and aluminous cements is considered to be similar to the hydration of anhydrous compounds, *e.g.*, the slaking of lime. In the case of Portland cement, where the action takes place directly with the solid constituents of the cement, internal stresses are set up, due to expansion, which may be sufficient to disrupt the mortar or to disintegrate it more or less rapidly. If, on the other hand, the reaction takes place only after the constituents have been dissolved in water, as in the case with aluminous cements, the crystallization of the reaction products may even increase the strength of the mortar. Slag cements seem to contradict this theory, as they seem to fix calcium oxide without previous solution of its constituents. R.G.E.

Contraction and expansion of concrete. H. RABOZEE. *Pit and Quarry*, **17** [7], 78 (1929).—Variations in length are caused by chemical changes during setting and hardening, variations in temperature, and in humidity. The chief changes are due to the latter, being 0.036% in an aluminous cement, 0.045 in a rapid hardening Portland, and 0.076 in a slag cement concrete. Age did not affect the intensity of the phenomena. R.G.E.

Cements resistant to acids. ANON. *Bull. Assn. Document.*, **18** [133], 9(1928).—Hydraulic cements resistant to acids are practically unknown. All cements are completely destroyed by acids after a very short time. One is therefore obliged to use clay tile which are acid-proof, but costly and not very stable, or tanks lined with clay tile and an acid-proof mastic, for applications wherein attack by acids must be considered. It is often necessary to use tanks of lead or glass. Baryta cement resists acids; it is a hydraulic cement slow in setting, but having a solidity near that of normal Portland cement. E.J.V.

Relation between composition and strength of cement mortar on combined hardening. I. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **31** [9], 200B(1928).—Recently, the combined hardening strength has become of much importance in the testing of cement mortar. N. observed in his studies on cements that the differences of compressive and tensile strengths of cement mortars between combined air and water hardening (1 day in moist air, 6 days in water, and 21 days in air curing) and those on common water hardening (1 day in moist air and 27 days in water curing) owe much to chemical compositions of cements. Two types (low and high silica types) of eight Portland cements were examined in regard to their tensile and compressive strengths in 1:3 standard sand mortars and chemical composition. Data are given in tabular form. E.J.V.

Setting of cement. I. HERMANN GESSNER. *Kolloid Zeit.*, **46**, 207–16(1928).—A critical review of the literature on the hydration, setting, and hardening of Portland cement. H.I.

Measurement and the importance of particle size of cement. DONOVAN WERNER AND STIG GIERTZ-HEDSTRÖM. *Zement*, **17**, 1002–1005, 1038–42, 1071–76 (1928).—A sedimentation apparatus is described with which the particle size of cements was measured. From the distribution curve and the specific surface of a given cement it was possible to predict quite accurately the compressive strength of the cement at any age,

other variables being controlled. The fineness or specific surface had a definite relation to the age at which a cement attains strength. (*C.A.*)

PATENTS

Composition added to cement mixings for cold glazes. JOHN LANGBEIN. U. S. 1,695,808, Dec. 18, 1928. A composition comprising a mixture of polymerized linseed oil, ammoniacal water, milk of lime, and infusorial earth in the proportions of 250:660:5750:1000 parts by weight, respectively, for the purpose set forth.

Discharge funnel for shaft kilns, especially lime shaft kilns. ANON. Ger. 451,403; *Rock Prod.*, **32** [1], 78 (1929). The discharge end of shaft kilns is designed in funnel shape and the discharge opening is made as small as possible in order to be able to attain easily an air-tight closure. The entire load of the charge in the shaft rests upon the discharge funnel, so that the material pinches in the funnel. In order to avoid these drawbacks, guiding plates have been provided in the shaft discharge funnel, which lead approximately from its axis in stream shape and at an incline, and are flat or curved, reaching from the intake cross-section downward against the discharge opening of the funnel. In this way the material discharging from the shaft is divided into individual streams and is guided to the exterior without displacement in the shaft and pinching in the opening of the discharge funnel. At the same time the discharge funnel is relieved in part from the load of the charge above it in the shaft. F.P.H.

Enamels

Action of fluorine in enamel smelts. H. G. WILCOX AND F. C. WESTENDICK. *Jour. Amer. Ceram. Soc.*, **12** [2], 82–86 (1929).—It is proved that all fluorine is not volatilized from enamels and that the duration of smelting and viscosity of smelt affect the amount driven off. These facts were determined by quantitative analysis of enamels of varied compositions smelted under varied time treatments.

Spray finishing equipment. ANON. *Brass World and Platers' Guide*, **24** [11], 348 (1928).—Spray finishing equipment is described in a number of pamphlets issued by the Spray-Lac Manufacturing Co., Chicago. E.P.R.

Smoothness of castings as affected by cores. H. L. CAMPBELL. *Refract. Jour.*, **4** [39], 92 (1928).—Tests were carried out to study the influence of core sand mixtures on the surface finish of gray iron, steel, and brass castings. A disk $^1/_2$ in. thick and 5 in. in diameter was cast in a standard mold, the two sides being lined with prepared cores. Cores were prepared from silica sand of various grain sizes, and of mixed grain sizes and also with additions of other sands and silica flour. It was found that with sands of uniform grain size the smoothness of the casting varied uniformly with the grain size. The addition of fine sands or other finely divided material to core sand mixtures within reasonable proportions does not appreciably improve the smoothness of the castings. The best finish was obtained from the core surface which had been rammed against the smooth bottom of the core box. The top "scraped-off" surface of the cores gave a rougher casting finish particularly with the coarse sands. E.P.R.

Value of molding sand tests. A. A. GRUBB. *Refract. Jour.*, **4** [39], 92 (1928); *Instruments*, **1** [1], 39 (1928).—The various tests for molding sands and their relation to each other are considered. There appears to be a relation between clay content and wet bond strength in a virgin sand, but not in a facing sand. Heating a sand to just over 300°C appears to affect the dry bond strength detrimentally. E.P.R.

Scottish molding sands. F. HUDSON. *Refract. Jour.*, **4** [39], 92 (1928); *Foundry Trade Jour.*, **38**, 262, 279 (1928).—A series of tests is outlined which can be conducted in a foundry laboratory on molding sands. The tests include sieving, green bond (overhang), subsidence, permeability, dry bond (tensile), refractoriness, and skin effect. The latter consists in embedding blocks of sand 2 in. wide in the bottom of a mold. By

using various sands a comparison of refractoriness is obtained by the amount of sand fritting obtained on casting, while the casting itself after sandblasting shows the skin-producing powers of the sands. The results of these tests on some 25 Scottish sands, including red sands, rotten rock, and silica sands, are given, and the conclusions to be drawn from the test results are briefly indicated. The preparation of molding sands is then considered. The results obtained from the use of hand mixing, milling in an ordinary pan mill, and milling in special types of mills are compared, and the advantages of the latter are clearly shown. Simplified tests for use in the foundry are described, which include green bond (overhang), permeability, mold hardness (ball impression), and moisture content. The results of these tests on molds rammed by various methods are tabulated. E.P.R.

Gas permeability of molding sand. F. MASKE AND E. PIWOWARSKY. *Refract. Jour.*, **4** [39], 92 (1928); *Die Giesserei*, **15**, 559 (1928).—A method of testing permeability has been developed in which a sand core is held in a horizontal tube and air under pressure is passed through. The pressure is measured also on the outlet side of the core, and the volume of air passing through the core is also measured. Formulas are given from which the permeability can be calculated. By fitting a similar core into the top part of a molding box and reading the pressure generated by pouring a casting, data can be obtained as to the gas volume passing through the mold by referring to curves prepared from the laboratory tests. The results of tests with such molds show an immediate generation of pressure on pouring the mold, which rapidly drops, but in about two minutes rises slightly, and then gradually falls as the casting cools. The explanation, confirmed by tests with green and dried molds, with and without coal dust, is that the first pressure rise is caused by the gases from the coal dust, steam from the sand, and gases from the metal. The second increase is probably due to combined water in the sand and water which has condensed in the cooler layers of sand and is re-evaporated. By placing thermocouples at different distances from the mold face the rate of rise of temperature of the sand was obtained. Tests were carried out in which the following factors were varied: moisture content, milling, sieving, loam addition, silica sand addition, coal dust content, sand preparing, casting thickness, casting temperature, mold hardness, blacking, dusting. The results show that the quantity of gas passing through the sand depends on the thickness of the casting, the casting temperature, the type of sand used, and especially on the coal dust and water content. E.P.R.

Foundry facing sands. C. PRESSWOOD. *Refract. Jour.*, **4** [39], 99 (1928).—Laboratory tests of foundry sands are reported and it is claimed that soon these tests will be so closely indicative of the practical value of the material that they will determine the selections and use of sand. The chief characteristics of a good sand are (1) resistance to heat without fritting or softening, (2) cohesive strength of "bond," and (3) good porosity and gas permeability. If by any means the permeability is lowered, either by too hard ramming or excessive use of moisture, serious defects are caused, such as "scabs," blow-holes, or burning off. The value of chemical analysis is discussed, and stress is laid upon the constitution of the sand particles. The refractory nature of the two chief components should be determined separately, as the results of softening tests showed that while the silica constituents remained practically unaltered, the clay portion might alter very considerably and cause wide differences in the behavior of the sand. E.P.R.

Effect of furnace atmosphere on steel. R. G. GUTHRIE. *Trans. Amer. Soc. Steel Treating*, **15** [1], 96–116 (1929).—Fundamental tests were conducted on atmospheres commonly met with in the various types of heat-treating furnaces, and 1500°F throughout was chosen for all tests as being an average temperature for the heat treatment of carbon steels of about the eutectoid composition. The reports are simple and compre-

hensive; photomicrographs are shown in which the type of steel, conditions of time, temperature, pressure, velocity, etc., are constant, the only variable being the different simple gases. An additional set of photomicrographs with explanatory notes is incorporated, showing some of the effects of mixing the gases in various proportions. The chemistry of combustion of gas has been added as an appendix. The paper is meant as a progress report on a subject upon which a great deal of work must still be done. The summary contains three practical conclusions as a result of the work thus far. E.P.R.

Modern furnaces for normalizing sheets. ANON. *Blast Fur. Steel Plant*, **16** [12], 1571–73 (1928).—A description is given of equipment lately installed for the continuous annealing of sheet steel. F.P.H.

Remedies for specks in enameled ware. ANON. *Ceram. Ind.*, **12** [1], 54 (1929).—Specks are sometimes caused in inferior feldspar, but the degree to which the feldspar will show in wet and dry enamel is different. In the wet process it is not noticed as much. Specks originating from feldspar can be easily identified because they come suddenly and occur all over the piece. When this form of specking appears, it is also wise to look for a mill lining that has become very badly worn. To prevent specks, inspect grinding mills after every batch to make sure that none of the brick has dropped out. After a new lining is put in a mill, put in a charge of sand and grind for several hours to smooth the lining. Different types of metal oxides in enamels will cause different kinds of specks. Iron with rust will cause a black circular spot with a ring around it. Lead sometimes causes a metallic lead spot, or a yellow spot the color of litharge. Zinc will make a large, spreading dark blue spot that once in the enamel it leaves only one alternative, and that is to re-sandblast the piece. Metallic antimony in molten enamel will show up in the finished product in the form of a little speck with a spangled halo around it. Other causes of specks are (*a*) spitting out of muffles of both the silicon-carbide and fireclay refractory type; (*b*) inferior grades of oil. Crude naphthaline which can be purchased at small cost will, if introduced into the oil tank in the amounts of 1 lb. to 800 gal. of oil, settle the sediment in the oil. This is sufficient for about two weeks, at which time a pipe can be inserted into the bottom of the tank and the water pumped out. A considerable amount of sludge will be found. F.P.H.

Opacifying power increased by mobility in antimony enamels. HANS MELZER. *Ceram. Ind.*, **12** [1], 59–60 (1929).—One requirement for the production of a good antimony enamel is to obtain one which has the easiest mobility, and the frit completely and homogeneously fused. The theoretical fusibility figures of a successful antimony white enamel are 1.15 to 1.25 and the ground coat used under the enamel has the fusibility of 0.94. The greater amount of antimony oxide used in the covering enamel, the more mobile should be the main enamel batch. The fusibility figures given correspond to additions of 3 to 8% antimony. As stated previously an addition of 8% antimony oxide is to be regarded as a maximum; in fact, in an ordinary batch containing both flint and feldspar, it is not good to introduce a greater quantity of antimony oxide than that given, since the enamel becomes very viscous and prevents a thorough fusing and proper mobility. When too much antimony is used the enamels are liable to become too brittle. The attainment of easy fusibility, decreases in feldspar content, and increases in portions of flint and fluorspar will allow more than 8% antimony in the batch. F.P.H.

New opacifier for vitreous enamels. ANON. *Ceram. Ind.*, **12** [1], 96 (1929).—The properties of white oxide are said to be ideal for use as an opacifier. It is claimed to have the highest index of refraction of all known white substances, of low specific gravity, and is absolutely nonpoisonous. Aside from its opacifying qualities, an additional advantage is the greater acid-resisting qualities of the enamel in which it is used. It is also being used in ground coats where it has no tendency to cause blisters. F.P.H.

Satisfactory opacifiers. ANON. *Keram. Rund.*, **36**, 507 (1928).—From the viewpoint of the German enamel industry the price of opacifiers is considered and Sb_2O_3 is suggested as a suitable and cheaper substitute for tin oxide. H.I.

PATENTS

Folding table with enameled top. HEINRICH TÜRK. U. S. 1,697,094, Jan. 1, 1929. A folding table comprising a sheet metal top having an integral depending peripheral flange, a top supporting structure with which the top is designed to be engaged when the table is assembled, the structure consisting of leg members, centrally disposed superposed plate members and upper and lower intermediate brace members, the outer ends of the brace members being secured to the leg members and pivotally secured at their inner ends to the plate members, the upper ends of the leg members having yieldable spring engagement with the flange of the top, whereby the top may be removed from the supporting structure by inward movement of the leg members away from the top, all of the leg members being pivotally movable substantially about the central vertical axis of the table to lie against and coincide with one another, and fastening means engaging the leg members and normally preventing the pivotal movement.

Tiled construction. OWEN E. GRIGSBY. U. S. 1,698,091, Jan. 8, 1929. Tiled construction comprising a supporting structure, a base sheet secured to the structure, the sheet having in its face two sets of parallel grooves, one set intersecting the other, and molded tiles cemented to the base sheet, each tile having a rib arranged centrally upon its back, and another rib intersecting the 1st-mentioned rib, the ribs lying in the intersecting portions of the grooves.

Glass

Producing ten different bottles simultaneously on a new automatic machine. ANON. *Ceram. Ind.*, **12** [1], 42–47 (1929).—A new type of bottle machine, automatic, having 10 heads, and capable of producing 10 varying types of bottles simultaneously at the rate of 80 a minute with single molds, and 160 with dual molds, is to be exploited by the Bullman Machine Co., which has acquired from H. Hillman, its inventor, the European rights for its manufacture and sale. The Hillman machine is of the continuously revolving type, entirely automatic, having 10 heads, each comprising a complete bottle-making unit. It is very compact but readily accessible and, considering the output, does not occupy a large amount of floor space, being only 8 ft. 6 in. diameter over-all. The machine is a suction gatherer, but is operated without the need of a revolving pot or special feeder; it utilizes a forehearth built on the side of the working tank and the glass flows naturally into the hearth and is kept in a state of flow by means of a mechanism attached to the machine, thus making the glass homogeneous and free from seed, and maintaining a constant temperature. An outstanding feature is the machine's ability to increase or decrease the setting time without varying the number of revolvings of the machine while it is in motion. It is possible, therefore, to set the machine to the time required for setting the smallest bottle, without running it at an objectionable speed. Equipped with molds of different sizes the Hillman machine can produce 10 various sized bottles on the one machine which vary considerably in weight, capacity, and dimensions. F.P.H.

Knox-O'Neill suction feed bottle machine. ANON. *Glass Ind.*, **10** [1], 18 (1929); *Nat. Glass Budget*, **44** [33], 3 (1928).—The Knox Glass Bottle Co., Knox, Pa., will produce a new bottle machine known as the Knox-O'Neill, developed in coöperation with Frank O'Neill, of the O'Neill Machine Co., Toledo, Ohio. The new machine model No. 60, as operated at the Knox plant, carries 6 blank and 6 blow molds and is designed especially for making ware up to 6 oz. in weight. It is of the vacuum-feed type and so de-

signed that 6 bottles, each of which may vary in design, finish, height, and weight, can be made during one revolution of the machine. Another model, No. 65, will be equipped with 8 blank and 8 blow molds capable of turning out 8 varieties of bottles at each revolution of the machine. The new machine incorporates the advantages of suction feed and eliminates many of the disadvantages of the gob feeder. It revolves continuously; no stoppage of the machine is necessary to feed the glass into the mold. The molten glass is taken from a revolving pot and a similar principle to that used in other vacuum processes is involved. The revolving pot, adjacent to the furnace and under cover, is supplied with molten glass through a channel. Each of the blow molds on the Knox-O'Neill machine is provided with its own blow head, which seizes the neck of the bottle and continues in contact with it until the blowing process is completed, thus preventing defects that often occur with the machines now in use. It is of value to the smaller manufacturers whose orders are not large enough to employ a 10- or 15-arm suction machine. E.J.V.

Gravity flow vs. suction feed process. VI. Feeder and efficient design. B. M. PEARSON. *Ceram. Ind.*, **12** [1], 48–51 (1929).—The nature of the ware to be made on the machine will determine the type of machine. Press ware, for instance, will be made on the press machine. The Owens machine was originally designed for wide mouth ware manufacture and some of the original licensees of the Owens Co. could only make narrow mouth ware on its machines under the terms of its license. Practical experience has shown that for narrow mouth ware the suction machine is preëminently the machine for quality. For wide mouth ware, it is more satisfactory to use a machine working on the press and blow principle, as better quality is obtained. Modern machines working on this principle are quite efficient and economical in operation. Small ware, of course, should be made on a machine especially designed for high-speed operation, to obtain the greatest producing efficiency. Where the machine must be largely run on bottles giving a special finish, such as internal screw, the machine must be chosen which is capable of making such special finish. For previous abstracts of this series see *Ceram. Abs.*, **7** [12], 820 (1928). F.P.H.

Electric lears. J. EARL FRAZIER. *Nat. Glass Budget*, **44** [29], 3(1928).—Glass is an amorphous substance being generally composed of a mixture of silicates and usually an alkali. In its finished form it generally has (if an ordinary glass container) a composition of 68 to 76% silica, 4 to 10% calcium oxide, 2½ to 7% magnesium oxide, 0.5 to 2% alumina, and 14 to 20% sodium oxide. It is insoluble in water and most acids except hydrofluoric acid (HF). Glass is made from the fusion of iron-free raw materials in clay pot furnaces or clay block tanks at temperatures of 2300 to 2800°F. The raw materials are generally sand, lime, lead, soda or potash, feldspar or lepidolite, boric oxide, and crushed cullet. These materials are carefully weighed and mixed and then fused in the furnaces or tanks until the dissolved gases emanating from the materials have been driven off. The type of fuel generally used in such furnaces is natural gas, producer gas, or oil. Electric energy is now gradually coming into use on a commercial scale for certain glasses. It has of course its many difficulties, such as discoloration, rate of flow, etc., which will in time be overcome Small tanks have yielded as high as 2 lbs. per kw.-hr. while an economical gas-fired tank will give ½ lb. glass to a cu. ft. of natural gas. A very new modern forming machine is the Redfern suction machine which pulls the glass into a cast-iron mold and then deposits it as a container on a conveyer ready to be annealed. The other automatic method is the flow spout or feeder method which regulates the flow of glass falling into forming machines also containing cast-iron molds. Glass has two distinct annealing temperatures. The upper annealing temperature is the temperature which will relieve the stresses or strains in glass very quickly and above which temperature an accelerated rate of such removals does not occur. The

lower annealing temperature is the temperature below which a glass will not be submitted to remaining strains or stresses or that the existing strains or stresses will not disappear in practical length of time. Due to the peculiarities of glass it must be annealed in order to make it commercial, that is, the molecules of its constitution must be in a state of equilibrium when the glass is cooled to room temperature. If this is not done we have what we call an unstable glass which might fly to pieces at the slightest shock or scratch. This tearing apart of the glass is caused from temporary strains or stresses set up in the article due to unequal rates of cooling of the various dimensions of the article such as sides, bottom, etc. To make a highly annealed bottle, it is necessary to remove these permanent strains. The forming machines deposit the containers on conveyers and the glass is ready to be annealed. In the fireless type of leer, the ware is fed to the leer before any strain has developed due to transportation, but the container retains the mechanical strains. The composition of the glass is an important factor in annealing. The shape, size, and dimensions of an article affect annealing. English and Turner have shown that a glass rod could be perfectly annealed by using a 3-stage process in annealing. The 2-stage method, with electric annealing, is adaptable for several types of ware in the leer at the same time. In the low-heat type leers it is essential that the leers be filled completely at all times and for that reason are run at speeds that will just take care of the ware of one or more shops, increasing the length of the leer for the heavier types of ware for the cooling. The methods of feeding leers can be either hand or automatic and there are advantages and disadvantages in both. To insure good annealing it is essential that the leer be free from drafts or cold spots. The superiority of electric leers over gas or oil-fired leers has the following features: (1) It improves the sales quality of the glassware as there is nothing to get on the ware except clean hot air, and (2) it prevents manufacturing losses that are caused by nonuniformity of heat throughout the fire box. Electric heat is one sure way to get uniform strain in a bottle at all times if the customer desires it by simply changing the temperature controls. These low-heat electric leers have experienced results as high as 139 lbs. per kw.-hr. for heavy types of ware with averages around 70 to 80 lbs. per kw.-hr. Machine production made continuous annealing necessary and now control and quality have made electric annealing imperative. E.P.R.

Making a hole through glass. W. F. SCHAPHORST. *Ceram. Ind.*, **12** [1], 47 (1929).—Use a hollow copper or brass tube of the size of hole desired. If the brass is hard, anneal it by heating it and then plunging it into water. File small saw-teeth in the end. These are necessary for holding the abrasive material. Place the tube in a vertical drill press and carefully rest the glass on a soft pad of paper, leather, or felt. Use 3 parts of turpentine and 1 part of ether as a lubricant. Run the drill at a slow speed of 15 to 30 r.p.m. and without much pressure. It takes about one-half hour to drill through a pane of glass one-eighth inch thick. F.P.H.

"Red Devil" circular glass cutter. ANON. *Nat. Glass Budget*, **44** [33], 18 (1928).—To meet the increased demand which has been created largely by the automotive manufacturers for rapid production circle glass cutter, Landon P. Smith, Inc., of Irvington, N. J., Windsor, Vt., and Hill, N. H., is manufacturing an improved machine of this type. An inexperienced person can cut 2000 or 3000 circles in 8 hours, any size from $\frac{1}{2}$ to $15\frac{1}{2}$ in. in diameter. E.P.R.

Glass furnace construction. A. ALISON. *Glass*, **5** [4], 144 (1928).—A. discusses and furnishes calculations for the following: Diminution in the cross-sectional area of the flues, capacity, stability of chimneys, brick chimney. Five important charts are given: (1) a chart connecting loss of draft with change in velocity of gases due to restriction of area of flues, (2) a chart connecting static draft with height of chimney, (3) chimney performance curves, (4) chart connecting volume of gases and area of

stack with loss of draft, and (5) chart connecting weight of gases and area of stack with loss of draft. A.J.M.

Effect of combustion conditions on glass furnace operation. D. J. McSwiney. *Glass*, **5** [4], 155 (1928); *Fuels and Fur.*, **6** [2], 171–74 (1928); for abstract see *Ceram. Abs.*, **7** [6], 350 (1928). A.J.M.

Interesting old bottle. Anon. *Glass*, **5** [4], 164 (1928); *Barnsley Chronicle*, July 24, 1875.—A glass-stoppered bottle for carbonated beverages is described. The bottle is of the usual size, the stopper being inside. It very closely resembled an ordinary marble, and when the bottle was filled the stopper fit tightly against the top of the neck. A slight pressure of the finger on the top caused it to fall to the bottom. The bottles could be filled at the rate of 50 per hour. A.J.M.

Belgian glass trade. Anon. *Glass*, **5** [4], 168 (1928).—A detailed discussion, with many statistics, of the Belgian glass trade in 1927 is given. A.J.M.

Glasses transmitting ultra-violet rays. Anon. *Glass*, **5** [4], 169 (1928).—The following are discussed: (1) Total transmission of various glasses for those ultra-violet solar rays to which common window glass is opaque; (2) spectral transmissions of various glasses for the ultra-violet rays; (3) solarization. Experimental data support the conclusions. A.J.M.

Manufacture of laminated safety glass. Joseph Rossman. *Glass Ind.*, **10** [1], 1–6 (1929).—Nearly all patents for laminated glass have been granted during the last ten years. The earliest attempts consisted in securing a sheet of celluloid between layers of glass. Laminated glass has found extensive use in goggles, aeroplanes, automobiles, bullet-proof partitions, and signal lights. Many difficulties have arisen in its manufacture. The cements used are subject to defects: (*a*) the laminae when ready for assembling are slippery resulting in imperfect product; (*b*) lack of sufficient bonding strength or adhesion; (*c*) lack of complete "fluid" transparency, thereby rendering the planes of surface contact more or less visible; (*d*) milky strata or cloudiness between the laminae; (*e*) excessive action on the celluloid layer, causing flabbiness, weakness, and great liability to form bubbles at slightly elevated temperatures; (*f*) the presence of solvents so volatile that permanency is either impossible or dependent altogether on an impervious seal at the edges; (*g*) presence of solvents so active that the celluloid surfaces immediately swell and become very slippery and so render the articles weak and very difficult to handle successfully; (*h*) the plastic binding material may develop objectionable coloration. One of the first patents is French patent 321,651 granted in 1902. The object of the invention was to provide a layer of celluloid on glass containers or tubes which are likely to be broken and lose their contents. The process is carried out by dipping the vessel in an acetone solution of celluloid, the concentration of the solution being varied in proportion to the desired thickness of the celluloid layer. After the immersion, the vessel is dried to evaporate the solvent. This process is repeated to obtain desired thickness. The first U. S. patent 830,398 was granted to John Wood, an Englishman, on Sept. 4, 1906. The invention consists in providing two sheets of glass between which is fixed or cemented a sheet or film of any transparent adhesive substance with sufficient elasticity to prevent splintering and provide hanging together of the parts. Two sheets of glass are fixed by means of a suitable cement, such as "Canada balsam," to a central sheet of transparent celluloid or other similar material capable of adherence to glass. Eduard Benedictus of Paris obtained U. S. patent 1,098,342, May 26, 1914. He used sheet celluloid coated with acetone. The method of the Benedictus U. S. patent 1,128,094, Feb. 9, 1915, consists in making reinforced glass by softening the surface of a sheet of celluloid by means of a volatile solvent, sandwiching the sheet between sheets of glass, subjecting the juxtaposed sheets to a vacuum to remove excess solvent, and then subjecting the sheets to atmospheric pressure while

the surface of the binding material is still pasty under the influence of the solvent, whereby the sheets are firmly pressed together. In his next U. S. patent 1,182,739, May 9, 1916, Benedictus discloses a process which relates to the use of gelatin as a reinforcing layer. Gelatin liquefies at comparatively low temperature and has the advantage of being readily attachable to glass or celluloid under the action of moderate heat without the use of a solvent. The present invention subjects the gelatin at the moment of sticking to a liquid such as 95% ethyl alcohol. The alcohol dehydrates but neither dissolves nor attacks the gelatin. A press for uniting the sheets of glass is described by Benedictus' patent 1,206,656, Nov. 28, 1916. In carrying out the invention of U. S. patent 1,223,135, April 17, 1917, the reinforced glass plates to be united have their juxtaposed surfaces coated with varnish or equivalent material, and under the coating of varnish of one or both plates is a reinforcing film composed of successive deposits of gelatin and celluloid and gelatin. The varnish on the glass is hardened before union of the plates is attempted, the surface of the varnish is softened by a solvent such as alcohol, and then the two plates are immediately put together and pressed tightly, so that the varnish on one plate will unite with the varnish of the other. The simplest form, U. S. patent 1,224,530, May 1, 1917, comprises two panes of glass, transparent retaining film of a suitable tough adhesive, and resilient cement such as glucose between. This retaining film may be applied to the opposing sides of the plates of glass while in a freely liquid state and then allowing it to dry to a viscous condition. In U. S. Alex Bardin's patent 1,228,165, May 29, 1917, the glass is first washed, then dipped into a 20% solution of chromic oxide in water to destroy all traces of grease, and dried, then coated with a weak solution of gelatin to form a thin film having the thickness of about 0.03 mm. When the gelatin film is dry it is coated with a solution of 1 or 2% of collodion or celluloid or simply nitro-cellulose dissolved in ethyl formate. If a haze is formed, it is removed by applying another solution, whose composition is given. The coating is allowed to dry, and then a celluloid varnishing and protecting coating is poured on. E.J.V.

Common types of press molds. ROY E. SWAIN. *Glass Ind.*, **10** [1], 7–12(1929).—An illustrated description of several types of glass molds, including the block mold, pedestal type mold, sectional block molds, molds having the two features of mold design (the lift-off cylinder and the "shovey up" valve), molds having "lift out rings," inverted molds, molds with spring bottoms, and overflow type molds having a spillway to accommodate excess glass. E.J.V.

Stem ware. ROY E. SWAIN. *Glass Ind.*, **10** [1], 12 (1929).—In stem ware unless there is a constriction near the bowl the stem will usually feed from the bowl or plunger end of the stem, producing an indentation or well in the bottom of the bowl. This surface produced by the plunger quickly reheats and offers little resistance to the pull of the contracting interior of the stem. Handles also have a tendency to do this. In some of the cheaper ware one may find handles that have piped as much as $^1/_4$ in. In some of the solid pieces where the manufacturer has sought to cut expenses by doing away with the font and making the job straight press, piping occurs $^1/_2$ in. in diameter by 1 in. or more in depth. Setting the surface enough to prevent the piping may produce magic blisters. This piping is often very pronounced in strain insulators, flower blocks, drawer pulls, etc., where a hole is formed in a heavy piece of glass by pressing glass around a pin. These holes in the finished ware are usually much larger than the pin formed in them. Wrinkles in press ware are formed when the glass or mold is cold. They may be reduced by making the molds relatively light in the section affected. The problem of deformed glassware is but one of the problems which owes its origin to the unequal cooling of the glass in manufacturing, for it is from this source that we get our annealing problems. E.J.V.

Great names in history of English glass. II. John Bellingham. F. BUCKLEY. *Glass*, **5** [4], 150 (1928).—Common window glass has been made in England from medieval times. Very little is known about the makers until the 17th Century although it is certain that large quantities of window glass were being made near London in 1550. The French were at this time making a much finer glass called Normandy glass because it was formerly made at Cherbourg in Normandy. In the reign of Elizabeth an attempt was made by John Carre to introduce the manufacture of this glass into England but he failed. Eventually, the English glassmakers acquired a knowledge of making this glass and improved upon it, making what was called Crown glass. There has been considerable doubt as to who really introduced the making of Crown glass into England. Hitherto the credit for the achievement has been given to John Bowles, a great London glassmaker, who did invent the best kind of Crown glass, called Ratcliff Crown glass. But it is now quite clear that John Bellingham was the man who first made this glass. He continued his business until the end of the 17th Century. In the middle of the 18th Century, the most famous Crown glass factories were the Bowles factory at Ratcliff and the Jeffery factory at South Shields. For Part I see *Ceram. Abs.*, **7** [9], 606 (1928). A.J.M.

History of Libbey-Owens Sheet Glass Co. WM. S. WALBRIDGE. *Glass Ind.*, **10** [1], 13 (1929).—Some personal reminiscences of the Libbey-Owens Sheet Glass Co. are given. The names "Libbey" and "Owens" are those of two men who came together from different walks of life, one as a manufacturer, the other as a workman and inventor, closely coöperating in the development and manufacture of glass. They changed conditions which existed from the era of the Phoenicians and Egyptians, and they are recognized by the glass world of this century as two of the most advanced men of the period. Furthermore, they became close friends and their lives closed within a short period of each other. E.J.V.

Effect of refractory walls on behavior of entrapped gas in glass melt. WILLI M. COHN. *Glastech. Ber.*, **6** [6], 295–303 (1928).—The importance of the nature of the refractory material used for glass tanks to the quality of the molten glass is emphasized especially where porosity of the walls enters in. According to investigations and observations made on pots and tanks a definite porosity of the wall must be maintained during the entire period of the melting process in order to do away with gas entrapped in the form of bubbles. As a precaution it was arranged to permit the determination of the porosity of a wall at high temperatures. E.J.V.

New Russian glassworks. ANON. *Pottery Gas.*, **54** [619], 81 (1929).—A big glassworks is being completed in the Tcherepovyetsk district. The construction of the main building is ready, and a railway branch 60 km. long connecting with the main line has been laid down. The machinery will be installed in the spring, and work will start in the summer. The output will be 5,000,000 sq. m. of glass. All the equipment for this big concern has been made in Moscow factories. E.J.V.

New beryllium glass. ANON. *Amer. Glass Rev.*, **48** [6], 13 (1928); for abstract see *Ceram. Abs.*, **7** [8], 520 (1928). E.P.R.

Chemistry of glass. W. C. TAYLOR. *Nat. Glass Budget*, **44** [28], 3 (1928).—Chemistry as applied to the glass industry and particularly that which relates more directly to the glass container is discussed. The organic glasses are still of no great commercial importance but development along this line should be watched as there is a remote possibility of something worth while being done in this field. Organic glasses have greater elasticity and strength. Alkali-free inorganic glasses have some advantages in chemical and electrical properties which may find a limited application although these glasses have certain disadvantages from the manufacturing standpoint in regard to melting and working. Silica-free inorganic glasses lack in general the

durability of silica glasses but may find some limited application where special physical properties are desired, and where the lack of durability of the glass can be overcome. Silicate glasses can be separated into four general types which we will call lime, lead, borosilicate, and colored glasses. The greatest of all these in tonnage is lime glass, the basis of the window and plate glass industry as well as the glass container field. While lime glass has its limitations, its cheapness, combined with reasonable durability and good resistance to weathering, has made it the most widely used of all glasses. It is a fused mixture of sand, soda, and lime. The percentage of each constituent may vary according to the use of the glass, and other elements may be added or substituted to improve certain properties. These changes usually increase cost, and are made with some definite advantage in mind. While the best lime glasses center around the molecular proportions of Na_2O-CaO-$6SiO_2$ we cannot give glass a definite chemical formula. In a general way it can be said that soda is used primarily as a flux to aid in melting, and its use is limited by the fact that it makes the glass more soluble and less resistant to weathering. It raises the coefficient of expansion, thus making the glass more difficult to work without checking, more difficult to anneal, and less resistant to temperature changes. Lime also serves as a flux at melting temperatures, and has a beneficial effect on the chemical resistance and surface hardness. Silica, while raising the melting temperature, is necessary in considerable percentage to obtain a durable glass of good working qualities. Excessive silica results in a glass too hard to melt and with a tendency to crystallize. Too little silica if combined with excessive soda gives too soluble a glass, if with excessive lime too quick a setting rate. Other elements may be added or substituted. Potash may be substituted in part or entirely for soda at a decidedly increased cost. For ordinary use it has no advantage. Lithia would have some advantages as a substitute for soda if it were not so expensive as to be prohibitive for ordinary use. It has much greater fluxing power offset by a greater tendency to devitrification. As a substitute for lime, magnesia is the element most frequently used. A mixture of calcium and magnesium oxides in about equal proportions gives a softer and a lower melting glass with a better working range than is obtained with either oxide alone. Barium and zinc may also be substituted but because of their expense are not used except where special properties are desired. There is no element which we exactly substitute for silica although alumina might be considered in this light. The use of small amounts of alumina has become more and more popular in recent years. It has the advantage of promoting chemical resistance and toughness, and tends to prevent crystallization. In addition to the major constituents, we have numerous minor constituents which formerly were not given much consideration, but which have in many cases been shown to be of importance. Most important of these is perhaps alumina. Other common impurities are small amounts of sulphates and chlorides, traces of water and carbon dioxide, fluorides, titanium and iron oxides, and sometimes many others. Arsenic is usually introduced as a clarifying agent and sometimes antimony or boric oxide is added in small amounts. Small traces of an element exert an influence on the glass in greater proportion than such constituents as alumina and boric oxide. The other three types of silicate glasses are briefly discussed. Lead glass is not as common as lime glass chiefly because of its higher cost of materials. Lead glass has certain decided advantages such as low melting temperature, long working range, and fairly high electrical resistance. Its disadvantage is that it does not lend itself to machine operation because it is difficult to get good quality lead glass from tanks. Borosilicate glass is made primarily where resistance to heat shock, or chemical or electrical resistance is needed. Because of its higher cost its use is limited to those fields where these special properties are required. There are two types of color, one of which is not affected by working conditions and is dependent on chemical composition for its uniformity. The other type, in addition to chemical composition, is dependent on a time-temperature cycle. In general, the

colors of the purple-blue-green end of the spectrum are produced by the use of direct coloring oxides not influenced by heat treatment. The oxides commonly used are nickel or cobalt for purple, cobalt with copper for blue, and copper or chromium or both for green. Many other oxides such as manganese, iron, titanium, cerium, vanadium, uranium, etc., are used in special cases for variations. Yellows are made most commonly with iron and carbon but can be produced in almost an infinite number of ways. Some yellows are appreciably affected by heat treatment, while others are not affected at all. Reds are produced by gold, copper, or selenium and all of these colors are very materially affected by heat treatment. White or opal is usually produced by fluorides or phosphates but can be produced in other ways. Practically all opals are dependent on heat treatment. E.P.R.

New substitute for glass. ANON. *Pottery, Glass, and Brass Salesman*, **38** [15], 17 (1928).—Attempts to break a substance which in the future may displace glass for some purposes have been unsuccessful. The substance has not yet been named but may be called glass; it is light in weight but does not break when dropped on the floor or struck with a hammer. It admits not only light but also ultra-violet rays. It is being developed in three directions: (1) as glass it is difficult to break and when it splinters it does not cut; (2) the substance comes in powder form and can be pressed into a mold which is heated, making electric light switches, covers, etc.; (3) a company at Northampton is using it to decorate dress materials such as velvet and cotton voile. E.P.R.

Important qualities of several glasses used for chemical purposes. O. KALLAUNER AND JOSEPH MATĚJKA. *Chemicky Obzor*, **2**, 8–11; *Chem. Zentr.*, **II**, 969 (1927).—K. and M. examined several common brands of chemical apparatus glass, as Jena glass, Eserco, Kavalier "Palex," Kavalier "S," and Resista. They report shape, surface, and appearance of the glass material; measurements, volume, and density of the glassware; resistance to sudden change of temperature and to impact; and the ability to resist the following: H_2O, 1% HCl, 20% HCl, concentrated H_2SO_4, 5% NaOH, and 5% NH_3. Tables are given for comparison. (*C.A.*)

Strained glass. P. LAZAREV. *Chim. et ind.*, **Special No.**, 441–43 (April, 1928).—Rapid cooling of SiO_2 glass to put it in a strained condition increases the hardness and the resistance to mechanical action and lowers the density and the specific heat. The same effect was observed with borax glass. Under polarized light strained glass is double refracting and exhibits parallel interference surfaces which vary with the form of the piece of glass and which are closer and more numerous near the surface than toward the center. When borax glass is heated to the softening point and cooled slowly (annealed) crystals are formed both at the surface and in the interior of the glass. When such a glass is treated with H_2O, solution does not take place uniformly over the whole surface but gives characteristic corrosion figures at various points: at the points where there are crystals the corrosion figures formed are regular, while at the points where there are no crystals the forms are curved and less regular. Investigation of strained glass by Laue's method showed that it has no crystalline structure. (*C.A.*)

Ampoule glass and p_H. GIOVANNI ISSOGLIO. *Giorn. farm. chim.*, **76**, 363–66 (1927).—The ampoules are autoclaved 2 hrs. at 110° with distilled water and compared with Na_2HPO_4-KH_2PO_4 solutions of p_H 7 to 8.2 with phenol red and bromothymol blue as indicators. (*C.A.*)

Classification of neutral glasses. EDUARDO BARONI. *Giorn. farm. chim.*, **76**, 66–71, 93–98 (1927).—Tirelli's objection that for glasses containing B hematoxylin (I) is less sensitive than phenolphthalein (II) is immaterial for practical purposes: I is decolorized only by 1% $Na_2B_4O_7$ but indicates it distinctly in concentrations of 0.9–0.0005%. On the other hand glasses containing much more borax than is practically

workable (10 to 25%) gave after autoclaving with water at 134° an immediate and distinct I reaction. Even alkaline glasses with the normal B content do not yield more than 186 mg. water-soluble extract, which is far below the inactivating B quantity. Moreover, I always permits the detection of inferior glass. Ampoules ought to be tested as follows: Test for acid (formed by decomposition of CaF_2 on fusing) with methyl red at room temperature or after slight heating with water. Autoclave 1 hr. with II at 134° (2 atmospheres). Sensitiveness: 0.005 mg. NaOH/cc. Glasses with a negative II test are sufficient for most purposes. Autoclave with bromothymol blue: sensitiveness 0.0004 mg. NaOH/cc. Autoclave with water and test with I. Use for all purposes only twice distilled deaerated water. Preparation of the indicators: triturate 0.05 g. methyl red in a neutral glass tube with 15 cc. 0.1 *N* NaOH, add 2 drops absolute alcohol, shake and heat moderately on the water bath until solution is complete. Dissolve in 100 cc. water, stir, filter, and dilute 10 cc. to 400 cc. To 100 cc. water add 1.5 to 2 cc. of 1% II, immediately before use. In a test-tube mix 50 mg. bromothymol blue and 5 cc. 0.01 *N* NaOH thoroughly, stir until the reaction is complete, decant, dissolve the residue in 5 cc. pure alcohol and add to the combined solutions 90 cc. water. Dilute 20 cc. to 500 cc. I is prepared in a 0.1% alcohol solution from C.P. crystals. (*C.A.*)

The soluble substance yielded by neutral glass in relation to its action on solutions for injection. EDUARDO BARONI. *Giorn. farm. chim.*, **77**, 223–38(1928); cf. preceding abstract.—Glass of better quality yields on autoclaving up to 0.007–0.008 mg. per ampoule of an inner surface area of 580 sq. mm. The results are always referred to 1-cc. ampoules. For the bromothymol blue test the indicator solutions are acidulated with 2.5, 5, 6, 7, 8, 10, 11, 12 cc. 0.001 *N* HCl/100 cc. Two good glasses, Fiolax and Tenax, were autoclaved 1 to 6 hrs. at temperatures from 100 to 134°. Fiolax yielded to the water 0.0008 mg. in 1 hr. at 100° and 0.004 mg. after 1 hr. at 134° or 6 hrs. at 100°. The increases of solubility with temperature and time are irregular. Tenax yielded 0.0006 mg. after 1 hr. at 100°, 0.0028 after 6 hrs. at 100°, 0.0015–0.002 after 1 hr. at 128 to 134°. The diagram shows parallel, unbroken straight lines. That this difference is entirely attributable to the difference in the composition of the original glass is doubtful for the following reasons. Considerable differences were found for ampoules of the same lot. Experiments showed also that the soluble alkali content of a length of glass tube and of test-tubes made from this tube by sealing one end was uniform throughout the entire length. Ampoules, however, made from this tube showed a different alkali content at different heights. It was markedly increased in the drawn-out part. Those annealed in the flame had a considerably higher soluble alkali content than normal ampoules (0.005 in Tenax and 0.006 in Fiolax instead of 0.002 and 0.004). Glasses of poor quality suffer a more marked decomposition by heat. (*C.A.*)

Physical properties of glass and their control. BERNARD LONG. *Rev. sci.*, **66**, 370–78 (1928).—A review of the properties of different glasses, the methods and apparatus used in their testing, and the factors affecting these properties. (*C.A.*)

PATENTS

Glass furnace. WILLIAM K. BROWNLEE. U. S. 1,695,528, Dec. 18, 1928. In drawing sheet glass, the method of supplying molten glass to the pool from which the sheet is drawn, consisting in melting the glass-producing materials, flowing the molten glass to the sheet source through a refining and cooling chamber, and simultaneously heating the lower strata and side portions of the flowing glass.

Method and means for treating glass. JOHN L. DRAKE. U. S. 1,695,538, Dec. 18, 1928. In glass apparatus, a tank containing a mass of molten glass, a pot communicating therewith, an upwardly extending projection arranged in the glass and over which the glass flows, means for heating the glass as it passes over the projection, and means for drawing a sheet vertically from the pot.

Drawing sheet glass. LAWRENCE A. GROLEMUND. U. S. 1,695,547, Dec. 18, 1928. In a sheet glass drawing apparatus, an inner container for a pool of molten glass from which the sheet is drawn, and an outer container surrounding the bottom and side walls of the inner containers but spaced therefrom, the space between the containers being filled with molten glass, and a heating chamber surrounding the bottom and side walls of the outer container, the sides of one of the containers being closer to the sides of the other container at their closed ends than at their open ends.

Glassware-annealing leer. PERCY Q. WILLIAMS. U. S. 1,695,788, Dec. 18, 1928. A leer comprising an annealing tunnel, a heating unit below the forward end of the tunnel, a vertical tube recuperator associated with the unit and opening into the annealing tunnel through the floor of the latter, means causing continuous recirculation of atmospheric air through the recuperator and predetermined portions of the tunnel, and means including slide valves for eliminating certain of the recuperator tubes from the path of circulation of air.

Machine for making glass containers. WARREN E. GLASPEY. U. S. 1,695,894, Dec. 18, 1928. In a machine of the character set forth, a rotatable mold carrier with a plurality of invertible molds, one of such molds being located at each stage; means for rotating the mold carrier step by step to bring each of the molds successively into position at each stage; a mandrel with a threaded tip arranged above each mold; means at one stage to lower the mandrel to move the threaded tip into the neck of the mold; means to cause inversion of the mold in its movement toward a succeeding stage; means for inserting a charge of glass in the mold at a succeeding stage while inverted; means for unscrewing the threaded tip of the mandrel to loosen the same from the glass charge; means for righting the mold in its movement toward a succeeding stage; and means for raising the mandrel from the glass charge in the mold at a succeeding stage.

Composite glass-feeder implement. PAUL G. WILLETTS. U. S. 1,696,661, Dec. 25, 1928. A composite implement for working molten glass comprising separate solid sections of different refractory materials, and means for joining the sections as a unit.

Drawing sheet glass. CLARENCE P. BYRNES. U. S. 1,697,104, Jan. 1, 1929. (1) An apparatus for drawing sheet glass, means for drawing the sheet glass in a generally vertical direction and then in a generally horizontal direction over a bending roll system, the bending roll system allowing sag of the intermediate portion of the sheet, and skewed rollers arranged to impart continuous side strains to the sheet in the region of the bend roll system, substantially as described. (2) That improvement in the art of drawing sheet glass which consists in bending the sheet from one plane to another while unsupported except at its edges, by applying lateral tension to the sheet during the bending operation.

Sheet glass forming apparatus and method. EDWARD DANNER. U. S. 1,697,227, Jan. 1, 1929. In an apparatus for forming sheet glass, a source of molten glass supply, means forming a horizontal spout from the source of supply to a point of discharge with the interior of the spout forming a tempering chamber, and means forming heating flues at the outer sides of the spout to heat the side walls thereof.

Burner for glass furnaces. PAUL R. VITTE. U. S. 1,697,334, Jan. 1, 1929. In a device of the character described, an elongated casing having compressed air inlet at one end, an oil pipe entering the casing at the same end and projecting therein, a mixing device having a perforated portion supported on the casing and projecting arms carrying a spray member, the spray member being in direct alignment with the oil pipe, and the depending arms being arranged flush with the wall of the casing, whereby compressed air will pass through the perforations of the mixing device and meet an unbroken spray of oil from the spray member, means supported by the casing for concentrating and

expanding the mixture, the casing at its outer end being of greater diameter than at any portion of its length, and a refractory lining within the enlarged portion.

Method and apparatus for producing sheet glass. RICHARD D. HUMPHREYS. U. S. 1,697,504, Jan. 1, 1929. The combination in sheet glass producing apparatus comprising forming rolls, conveying and leer rolls in operable relation to the forming rolls, means for intermittently driving the forming rolls at one speed, and means for driving certain of the conveying and leer rolls at another speed with a set of idler rolls extending from the forming rolls to the driven conveying and leer rolls for a distance at least equal to the length of the glass sheet being formed.

Polishing of glass surfaces. JOSEF PIVIN. U. S. 1,697,609, Jan. 1, 1929. The method of treating glass surfaces, which consists in grinding and smoothing surfaces, then subjecting them to a preliminary polishing operation performed with softer tools and abrasive materials used for grinding and smoothing, the materials having first been reduced by the grinding and smoothing operations to a degree of fineness in which they can no longer be applied by hard grinding tools, and giving the final polish to the surfaces.

Damper control for leers. CLAUDE NAGLE. U. S. 1,697,996, Jan. 8, 1929. Apparatus for annealing glassware comprising a tunnel, a flue associated therewith, a plurality of dampers disposed at intervals along the flue for controlling the temperatures therein, and means for collectively controlling the settings of certain dampers, including a longitudinally extending rod, means for rotating it, a worm wheel mounted to be rotatable with each damper, a bracket yoke fixed to the leer adjacent to each worm wheel, and a worm coacting with each worm wheel, each worm being disposed between the arms of one of the bracket yokes, and mounted in fixed angular but longitudinally movable relation to the rod, whereby to permit the longitudinal expansion of the leer by heat without influencing the settings of the dampers.

Pot-draining device for glass-blowing machines. FREDERICK A. OST. U. S. 1,698,000, Jan. 8, 1929. In a machine of the character described, an upwardly extending column tiltably mounted at its lower portion, and a pot operably mounted at the upper portion of the column.

Apparatus for polishing plate glass. HALBERT K. HITCHCOCK. U. S. 1,698,365, Jan. 8, 1929. In combination in polishing apparatus, a runner frame, having on its upper side a plurality of concentric annular troughs, runner blocks carried by the frame, annular polishing disks of yielding material carried by the blocks, a conduit extending down to each trough for supplying a polishing mixture thereto, and conduits leading from the troughs to the openings at the centers of the disks.

Regulating glass temperatures in drawing tanks. WALTER G. KOUPAL AND JOSEPH S. GREGORIUS. U. S. 1,698,369, Jan. 8, 1929. The method of regulating the temperatures on opposite sides of the draw bar in a glass drawing tank communicating with a melting tank and provided with a gate between the tanks projecting down into the glass, which consists in lowering the gate farther into the glass to secure an increase in the temperature of the glass on the far side of the bar and a decrease in the temperature of the glass on the near side of such bar, and in raising the gate (but still keeping it in the glass) to secure a decrease in the temperature of the glass on the far side of the bar and an increase in the temperature of the glass on the near side of the bar.

Apparatus for making composite glass. WILLIAM ORLAND LYTLE. U. S. 1,698,371, Jan. 8, 1929. Apparatus for applying pressure to a set of sheets to be joined together, comprising a relatively fixed plate and frame member spaced apart in opposition to each other, the frame member having a chamber facing the plate, a flexible diaphragm seated across the face of the chamber, a tray between the plate and diaphragm comprising a frame provided with a bottom adapted to carry the sheets, and means for sup-

plying fluid under pressure to the chamber, the plate and frame member being spaced apart just far enough to receive the frame of the tray.

Apparatus for drawing glass. JOHN A. SWEET. U. S. 1,698,378, Jan. 8, 1929. In combination in a glass drawing apparatus, a plurality of sets of traction rolls arranged in series for gripping the glass therebetween, one of such rolls having a longitudinal groove, and a receptacle located beneath the roll in position to receive any glass particles or chips collected by the roll and carried thereby around the roll to gravity discharge position above the receptacle.

Apparatus for annealing sheet glass. VERGIL MULHOLLAND. U. S. 1,698,479, Jan. 8, 1929. Apparatus for annealing sheet glass, comprising a tunnel, means for transporting sheet glass therethrough, a heating flue extending longitudinally above the tunnel and communicating with a fire-box located above the receiving end thereof, a heating flue extending longitudinally beneath the tunnel and communicating with a fire-box located beneath the receiving end thereof, and means located at intervals longitudinally of each of the flues for controlling the temperatures in different zones of the tunnel.

Apparatus for annealing glassware. VERGIL MULHOLLAND. U. S. 1,698,480, Jan. 8, 1929. Apparatus for annealing glassware comprising a tunnel having a nonplaniform wall and a metallic sheet having a bright heat reflecting surface secured to the wall and conforming to the configuration thereof and adapted to reflect heat transversely of the tunnel.

Method and apparatus for producing colored glass. EDGAR J. BRAUSSEUR AND WILLIAM R. GEDDES. U. S. 1,698,491, Jan. 8, 1929. Apparatus for producing colored glass, including means for flowing a layer of colored glass upon the surface of a moving body of ordinary more or less colored glass, and means for drawing upwardly from the body a glass sheet which is plain on one side and colored on the other.

Sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,698,492, Jan. 8, 1929. In sheet glass apparatus, including a tank furnace and a mass of molten glass, means for drawing a sheet therefrom, a heat-absorbing shield for protecting the sheet from the heat and gases from the furnace, the shield being curved to expose more of the central portion of the molten glass to the atmosphere than the edge portions.

Glass-cutting table. CARL E. NORCROSS. U. S. 1,698,506, Jan. 8, 1929. The combination of a table having a plane sheet-supporting surface, pins arranged at the forward and rear ends of the table, a straight edge having one end received between and maintained in position by certain of the pins, and pivotally mounted means carried by one of the other pins and engaging the opposite end of the straight edge to effect alignment of the straight edge with adjacent edge of table.

Drawing glass. R. SALOMON. Brit. 298,561, Dec. 5, 1928. (1) The machine for drawing glass tube and rod is provided with a drawing apparatus consisting of pairs of rollers that grip the tube between them and hold it with a pressure depending on the resistance offered to the drawing. (2) *Drawing mechanism:* The drawing apparatus comprises pairs of rollers which are mounted vertically above the drawing pot and engage the glass tube. Each roller is secured to the end of a shaft which is journaled in a sleeve and pairs of such sleeves are rotatably mounted on parallel shafts. (3) *Cutting:* The device for cutting the glass tube into lengths consists of a cutting disk secured to the shaft of an electric motor.

Glass manufacture. CORNING GLASS WORKS. Brit. 298,908, Dec. 12, 1928. Relates to the production of glasses which transmit a high proportion of ultra-violet rays by using batch materials which are free from iron and titanium. The present invention deals with the production of such glasses in commercial quantities, as lenses or as sheets of 10 x 8 in. area and $^1/_8$ in. thick. The silica may consist of vein quartz which has been

crushed and then washed with hydrochloric acid to remove any iron introduced during crushing. Ground sand may also be purified by converting it into silicon fluoride and decomposing the latter with water. In making a borosilicate glass, a boron compound is added to the batch in such a quantity that, in the resulting glass, the sum of the percentages of silica and boric oxide is from 10 to 22 times the sum of the percentages of alkalis, and the percentage of silica is at least 5 times that of boric oxide. When iron is present, a reducing material is necessary and carbon is convenient for this purpose. Carbon imparts a yellow or amber color to the glass, but the addition of zinc oxide neutralizes the yellow color and the resulting glass has a bluish green tinge. The batch is melted in pots made of fused quartz or in small tanks constructed of good quality silica bricks. The air and fuel gases used for heating the furnace are preferably filtered, and burners with nickel tips are used to prevent the introduction of iron scale. Glasses which transmit ultra-violet rays are found to lose gradually their power of transmission on continued exposure to ultra-violet rays or sunlight. It is found that if such glasses are heated, the transparency to ultra-violet ray is restored. Preferably the glass is heated to a temperature approximating its annealing temperature.

Glass manufacture. COMPAGNIES REUNIES DES GLACES ET VERRES SPECIAUX DU NORD DE LA FRANCE. Brit. 299,034, Dec. 12, 1928. A process for making plate glass consists in melting the glass in pots, pouring the whole contents of a melting pot into the receiver of a rolling apparatus, heating the mass of glass while it remains in the receiver, and annealing the glass strip formed by the rolling apparatus in a leer provided with conveying rollers.

Heavy Clay Products

Brick displaces cinder block. ANON. *Brick Clay Rec.*, **73** [13], 894–96(1928).—An account is given of the activities of the Philadelphia District Brick Mfrs.' Assn. in substituting brick for cinder block. Investigations of the laws and inspection of all the building operations resulted in the condemnation of cinder-brick for construction work, and the reëstablishment of brick in its rightful place. The largest Philadelphia banking institutions issued instructions to its loan department not to grant any further loans for building operations using either cinder or cement brick or blocks. E.J.V.

Extending the brick market. J. J. STEIN. *Brick Clay Rec.*, **73** [13], 898 (1928); *Clay-Worker*, **90** [6], 469 (1928).—The successful development of extended markets for brick in all grades of residential construction hinges entirely upon this industry establishing the facts regarding comparative costs between brick and substitute materials. The investigations and studies conducted by the Alton Brick Co., Alton, Ill., which resulted in the building of 100 brick homes where one had been a rarity, are discussed, and some interesting points revealed are enumerated. E.J.V.

Growth in use of brick. ANON. *Clay-Worker*, **90** [6], 445–47 (1928).—The Common Brick Mfrs.' Assn. of the Carolinas, under the leadership of its secretary, R. H. Davider, convinced the officials of the Proximity Mfg. Co. of Greensboro, N. C., that brick was preferable in the building of operative houses. Six hundred homes have been built of brick. There are great possibilities in many other centers for similar work E.J.V.

Carey Brick Co. ANON. *Brick Clay Rec.*, **74** [1], 30–36(1929).—The new plant of the Carey Brick Co., Chicago, Ill., was erected on the site of the old Bohnsack Brick Co. which was destroyed by fire in August, 1927. As the Bohnsack Co. decided to locate elsewhere on rebuilding, the Carey estate set up a modern unit for the making of common brick utilizing the clay deposits. The plant is described in detail. E.J.V.

Modern Hudson River brick plant. F. A. WESTBROOK. *Clay-Worker*, **90** [6], 461–66 (1928).—The plant of the Empire Brick & Supply Co., at Stockport, N. Y., is one of the Hudson River plants which, under progressive management, has been kept modern and represents many interesting features. The process of keeping a large plant

up to date virtually means that some part of it is usually under construction. A detailed description of the equipment of this plant is given. E.J.V.

New stiff plastic machine. T. C. FAWCETT. *Brit. Clayworker*, **37** [439], 309 (1928).—A new repress machine, working synchronously with the usual stiff plastic equipment, has been recently patented in Leeds, England. The main object of this machine is to impart equal pressure and density to the top and bottom faces of brick. The principle of the machine is as follows: 2 crossheads are secured to the upper and lower ends of 3 massive columns which are free to slide in the stationary bosses attached to the main frame of the machine. To the upper crosshead is anchored one member of the toggle pressing motion, the lower crosshead forming the base for the bottom piston. The front column also acts as a guide for the top pressing plunger. The effect of this construction is as follows: when the toggle action causes the downward pressure on the brick to exceed the upward resistance of the bottom plunger, the upward thrust exerted by the toggles upon the top crosshead tends to move it upward, and in so doing to raise the lower crosshead and cause the lower plunger to exert an upward live pressure on the brick. R.A.H.

New brick and tile plant develops capacity operations. O. H. BARNHILL. *Ceram. Age*, **12** [1], 23–26 (1928).—B. gives a description of the location, raw materials, plant equipment, and operation of a brick and tile plant at Catalina Island, Calif., having a capacity of about 50,000 brick and tile per day, which was built nine months ago. Of particular interest are the methods used for kiln bracing, $2^1/_2$-in. steel cables being used; color effects obtained by the use of local ores; and convenient deposits of diatomaceous earth for use as a filler and for insulation. An expansion program includes a tunnel kiln. A.E.R.W.

Effect of strength of brick on compressive strength of brick masonry. J. W. MCBURNEY. *Ceram. Age*, **12** [2], 47–51 (1928).—Presented at the Annual Meeting of the A.S.T.M., Atlantic City, N. J. A.E.R.W.

White efflorescence appearing on brick and tile (during baking). K. ZIMMERMANN. *Klei*, **19**, 1–8, 79–80 (1927); *Chim. et ind.*, **20**, 284–85 (1928).—A discussion of the causes of their formation and of the methods of preventing them. (*C.A.*)

PATENTS

Machine for veneering brick. EMMETT V. POSTON. U. S. 1,695,293, Dec. 18, 1928. A machine for substantially projecting and embedding granular veneer materials approximately at right angles into the exposed faces of a plastic clay body by means of mechanical rotating paddle blasting or centrifugal projecting of the materials, and means for moistening the materials.

Building block and wall. HARRY L. STRAND. U. S. 1,696,818, Dec. 25, 1928. A tile building block adapted for use in a wall as a backing for a predetermined number of superimposed bonded face courses of brick and formed with an approximately square wall of required dimensions to conform to the face courses, the block being pre-formed with one edge of the square wall a predetermined amount shorter than the edge at right angles thereto to provide, when either light or hard fired, one of the edges with substantially no greater height than the required square dimensions when the block, if turned at right angles, projects a substantial distance above the top of the face courses.

Building block. JOHN J. WHITACRE. U. S. 1,696,992, Jan. 1, 1929. A building block having a hollow rectangular head, and a hollow rectangular tongue arched at its inner end extending from one side of the head intermediate the ends thereof, the height of the tongue being substantially one-third the height of the head, and the tongue being located nearer to one bearing face than to the other bearing face of the block.

Brick-siding machine. JESSE AND HARRY FULENWIDER, EDWARD WILLIAM ROBINSON, AND HARRY NORRIS. U. S. 1,698,434, Jan. 8, 1929. In a machine of the char-

acter described, a plurality of forming rolls, a driving shaft, gearing through which the rolls are driven by the shaft, a slidable clutch element, and a driving pulley on the shaft, the pulley including a clutch element coöperating with that first-named, a pivoted member for releasing the slidable clutch element, a rotatable cam driven in timed relation to the rolls, the pivoted member including a laterally offset slotted arm and a slidable device on the arm including a cam engaging lug, this device on the arm when engaged operating the pivoted member and releasing the clutch, and means for mounting the cam for adjustment angularly of its path of rotation.

Refractories

Discussion on "Prevention of Disintegration of Blast-Furnace Linings." R. P. HEUER. *Jour. Amer. Ceram. Soc.*, **12** [1], 30–31 (1929).—Evidence is given that catalytic deposition of carbon in blast-furnace brick is caused by the lower oxides of iron. H. advises rather than merely reducing the iron that the iron be combined in the eutectic FeO-Al_2O_3-$2SiO_2$ which is not attacked under reducing conditions. This is a discussion of the article by H. K. Mitra and A. Silverman (*Ceram. Abs.*, **7** [6], 368 (1928).)

Strength of refractory materials at elevated temperatures. HANS HIRSCH. *Ber. deut. keram. Ges.*, **9** [11], 577–96 (1928).—The strength of refractory materials as a function of the temperature is discussed at length and considerable data are collected on the subject. An apparatus for determining the compressive strength of refractories over the range 20 to 1400 °C is described in detail. The following results are reported on a series of Al_2O_3·SiO_2 refractories.

Kind of brick	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)
SiO_2	54.7	55.0	59.6	63.2	71.5	72.9	82.0
Al_2O_3	43.9	42.4	37.2	31.6	26.3	23.7	16.4
Fe_2O_3	1.1	1.7	1.5	2.8	1.1	1.0	0.8
TiO_2	0.7	1.2	2.4	2.2	1.2	1.7	0.9
Total flux	2.1	3.8	5.6	7.4	3.4	5.1	2.5
Specific gravity	1.96	1.94	1.83	2.01	1.82	2.0	1.92
Volume porosity	28.4	28.1	29.9	24.7	29.8	24.5	27.8
Softening point under load of 2 kg./sq. cm.							
Initial point	1450	1430	1340	1270	1390	1335	1375
End point	1730	1570	1570	1550	1560	1530	1570
Cone fusion (°C)	1790	1760	1730	1690	1690	1670	1700
Compressive strength in kg./sq. cm.							
At room temperature	50	212	133	164	160	168	123
At 800°C	74	193	145	176	210	195	220
At 1000°C	97	268	334	524	444	880	430
At 1200°C	250	160	183	125	84	210	170
At 1400°C	53	37	35	20	48	90	53

The effect of the method of preparation and the effect of the addition of various materials including fluxing materials on the strength of refractories at various temperatures is studied. F.P.H.

Value of insulation in the steel plant. L. B. MCMILLAN AND J. D. VAN VALKENBURGH. *Blast Fur. Steel Plant*, **16** [12], 1560–66 (1928).—A practical review is made of the various applications of heat insulation to furnaces and auxiliary equipment. Cost and savings compared show substantial returns on the investment. F.P.H.

Properties of refractories. J. B. SHAW. *Blast Fur. Steel Plant*, **16** [12], 1610–13 (1928).—Representative refractory materials have been classified by collecting available data on their more important properties such as fusion temperature and resistance to load at high temperature, to spalling, and to slag. The materials selected were silica

brick, magnesite brick, chrome brick, diaspore brick, and fireclay brick. Figuring the relative quality of these brick with respect to the properties outlined on a percentage basis, the results obtained were so absurd that the problem was abandoned. No two laboratories apparently follow the same procedure in making the simplest tests on refractories. It is difficult to find cases of agreement even on the fusion temperatures of refractories. The greatest need of the refractories industry today is a definition of terms, standardization of methods of testing, and coöperation of all agencies in securing data which can be interpreted in the light of data already available. F.P.H.

Investigations on refractory materials in the U. S. in 1927. W. STEGER. *Feuerfest*, **4** [8], 117–24 (1928).—S. gives a descriptive bibliography on refractories, covering the publications on this subject appearing in the American journals during the year 1927. F.P.H.

Transformation appearance of silica brick in the crown of the Martin furnace. W. E. GROUM-GRJIMAILO. *Feuerfest*, **4** [8], 129 (1928).—G. discusses the 4 zones that appear in a silica brick that has been in service for a considerable length of time in the crown of a Martin furnace. These zones are classified as follows: (1) under zone or gray zone which is principally cristobalite, (2) black zone contains principally tridymite, (3) brown zone about one-half tridymite, (4) zone in which the silica is in the same stage of transformation as it was when the brick was placed in the crown. Chemical analyses of these various zones:

Zone	Color	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	MnO	K_2O	Na_2O	SiO_2 Phase
(1)	Gray	90.1	0.7	5.1	2.4	0.6	0.18	0.22			Cristobalite
(2)	Black	83.5	3.7	7.85	2.57	1.5	0.15			0.6	Tridymite
(3)	Brown	86.45	4.2	3.30	0.64	4.7	0.3			0.3	Tridymite + quartz
(4)	Normal silica brick	93.20	2.05	1.70		2.5	0.1			0.2	Tridymite + quartz

Disintegration of blast-furnace refractories by carbon monoxide. E. DIEPSCHLAG AND KARL FEIST. *Feuerfest*, **4** [9], 133–36 (1928).—The cause of the disintegration of blast-furnace refractories is the adsorption of carbon which is deposited by the reduction of carbon monoxide to carbon in the presence of a catalyst. F.P.H.

Progress in refractories in England in the years 1926 and 1927. W. STEGER. *Feuerfest*, **4** [10], 149–56 (1928).—S. discusses the articles on refractories appearing in Vol. 26 of *Transactions of the Ceramic Society* (England). F.P.H.

Preparation of refractories for glass melting furnaces in Russia and proposals for standardization. PETER P. BUDNIKOFF. *Feuerfest*, **4** [11], 165–68 (1928). F.P.H.

Methods of research newly applied to refractories. WILLIAM F. BOERICKE. *Min. and Met.*, **10** [265], 16–18 (1929).—There are certain essential properties that the theoretically perfect refractory should possess, which serve as standards toward which a manufacturer aims. These have been stated as follows: (1) high softening and melting points under normal load, (2) high resistance against sudden and sharp changes of temperatures, (3) chemical inertness when confronted with the influence of metal oxides, fluxes, and products of combustion that cause corrosion, (4) minimum possible change of shape and volume under all furnace conditions, (5) high resistance to mechanical stresses and shocks, in both hot and cold state, (6) uniform composition, so that a buyer may be sure at all times to receive this identical product. The petrographic microscope has here been adapted during the past year as a research tool for the study of refractory materials and it is believed by the laboratory technologists to have shown much practical importance. In general, three lines of attack are followed in working out problems from a petrographic angle. (1) Thin sections of the brick or mineral

may be made. These sections are ground down to a thickness of 0.001 in. or less until they become transparent. Under these conditions the various crystalline forms present are discernible and it is possible to study them by means of their optical properties. The size, shape, and the degree of inter-fitting of the grains of the material under examination also become apparent. If the section is that of a brick which has been subjected to slagging action, it is possible to trace the action of the slag on the various mineral constituents. (2) The brick or mineral may be reduced to a fine powder. This procedure is followed to permit identification of the various phases present by means of certain optical properties which are not possible to measure in thin section. (3) Melts of several grams may be made up to two or three components in various concentrations and these subjected to different temperatures for varying lengths of time. An electric molybdenum wire-wound resistance furnace operated with an inert atmosphere of nitrogen inside and equipped with the proper temperature regulating and recording devices is used for this purpose. It is possible to anticipate in part from microscopic examination of the materials exposed in this small furnace what will happen in the firing treatment of a kiln of brick involving many tons of material. Slag reactions can be duplicated in part in this furnace as well. In general, this furnace is used to establish not only the different mineral phases likely to form in the manufacture or use of a refractory but also to determine their stability relations at different temperatures. In research work devoted to a study of the disintegration which fireclay brick sometimes undergo in blast furnaces, due to the catalytic action of the iron oxide present in the refractory acting upon the furnace gases, the petrographic microscope has been of service in developing a fireclay brick free from this trouble. Magnesite and chrome brick do not set up this catalytic action. The theory is that the small amount of iron oxide present in the ordinary fireclay brick as an impurity reduces the CO in the furnace gas to carbon and CO_2. The former deposits around the iron oxide particles and exerts sufficient pressure to disrupt the bond of the brick. F.P.H.

Glass tank refractories and their chemical relationship to molten glass. KAI-CHING LU. O. S. U. Eng. Expt. Sta., *Bull.*, No. 44 (1928).—The work may be summarized as follows: (1) Two types of glass tank refractories were studied with respect to their chemical relationship with the molten glass, one aluminous and one siliceous. (2) Calcination of the aluminous clay to cone 16 at the end of 60 hours failed to reveal any volatilization of alkalis and alkaline earths. (3) Microscopic examinations were made on two samples, the aluminous clay fired to cone 28 and the siliceous clay fired to cone 23+. Indices of the aggregate and the glass were measured. (4) A series of SiO_2–Al_2O_3 glasses were prepared and the refractive indices and specific gravity were determined. (5) Mullite content was determined by (*a*) refractive indices and specific gravity measurement, and (*b*) hydrofluoric acid digestion. The aluminous clay fired to cone 28 contained 46% mullite. The siliceous clay fired to cone 23 contained 14%. (6) Mullite obtained from hydrofluoric acid digestion of the fired sample gives $\alpha = 1.67$ and $\gamma = 1.70$. Chemical analysis gives 1.27% Fe_2O_3 and 3.16% TiO_2. (7) The physical properties of the glass matrix were studied. Relative viscosity was determined. The siliceous glass is more viscous than the aluminous glass at their respective fusion temperatures. (8) Microscopic examinations were made on six samples of used tank blocks. The porcelaneous layer adjacent to the refractory, the brown layer in the case of aluminous blocks, and the milky white layer in the case of siliceous block were examined. Mullite and in some cases corundum and an aluminous glass were found in the porcelaneous layer. A soda-lime feldspar was found in the brown layer in the case of aluminous blocks, while cristobalite was found crystallized out in the milky white layer in the case of siliceous blocks. (9) Chemical analysis was made on the brown layer. It corresponds to a feldspar glass of the composition

$\left.\begin{matrix}0.64\ (NaK)_2O \\ 0.36\ (CaMg)O\end{matrix}\right\}$ $0.55\ Al_2O_3\}3.57\ SiO_2$. (10) The data are thoroughly discussed from the standpoint of thermochemical equilibrium. F.P.H.

Spray gun for refractories. ANON. *Brass World and Platers' Guide*, **24** [9], 290 (1928).—The S. Obermayer Co., Chicago, has placed on the market a spray gun for use in relining and repairing furnaces and other equipment where refractories are used. The new apparatus, known as the "Esso Refractor Gun," is stated to be capable of building up a wall from $^1/_2$ to $1^1/_2$ in. thick, mechanically mixing its cement and throwing it into place. E.P.R.

Frinkite: a revolution in refractories and their use. R. L. FRINK. *Nat. Glass Budget*, **44** [34], 3 (1928).—A new refractory material has been developed and tested thoroughly by actual severe use. It takes its name partly from its inventor and is to be marketed as "Frinkite." The knowledge today resulting from the research conducted by colleges and public and private institutions dealing with ceramics during the last decade teaches that resistance to erosion of refractories by molten glass is not determined by density of refractory, combustion, or temperature as much as homogeneity, shrinkage, and coefficient of expansion. Its characteristics are minimum solubility, homogeneity, unit surface of contact, low shrinkage, low and uniform expansion resistance to high temperatures without deformation, and low heat conductivity, together with a reasonable first cost, etc., all of which scientific research pointed to be the practical problems which might be wholly or partly solved by a satisfactory refractory material. Science has shown that the neutral and natural silicates of alumina in the form of sillimanite or mullite have the highest resistance to solution or erosion by glass and its constituents of any known material that is available in a practical way. Many uses of Frinkite are described in detail. Frinkite is a substance consisting principally of sillimanite, bonded together with other materials which at ordinary temperatures acts as a cement, but which upon heating to a required temperature (depending upon the formula used and the use to which it is put) undergoes a chemical reaction that produces a hot bond. The fired bond after a required period of heating has substantially the same coefficient of expansion as the sillimanite and its fusion point is but little lower. Bottom, side walls, crown, and shapes can be cast *in situ* and substantially monolithic in character. Frinkite is now being produced in a number of different grades. E.P.R.

Comparison of properties and industrial durability of lime-bonded and clay-bonded silica brick. W. J. REES AND W. HUGILL. *Refract. Jour.*, **4** [37], 8–15 (1928); Brit. Nat. Res. Assn., *Bull.*, No. 15 (1928).—The relative merits of clay- and lime-bonded silica brick have been debated for some time, and in view of the small amount of definite information with regard to the production and properties of clay-bonded brick the Council of the British Refractories Research Assn. decided on thorough investigation. **I.** A series of preliminary experiments were carried out with small brick made in the laboratory. Comparison lime-bonded brick of the same grading were made with lime proportions from 0.5 to 2.0%. Six different quartzites from various parts of the country were used. These preliminary experiments indicated the feasibility of making clay-bonded silica brick with quite small proportions of bond. The raw batches had satisfactory molding properties and sufficient strength when air-dried to permit handling. The fired brick were comparable in strength and other properties with lime-bonded bricks. **II.** As a result of these preliminary tests it was decided to make a series of batches of brick of standard size ($9 \times 4^1/_2 \times 2^1/_2$ in.) and to use a larger variety of clays for bonding. The preliminary experiments had shown that deflocculation of the clay slip considerably increased both the rate and efficiency of the covering of the grains of crushed stone with the clay bond. The grading used for these larger batches was similar to that found in commercial lime-bonded silica brick which were examined

in the green condition. The bonds used included four ball clays, two china clays, a plastic fire clay, and a marl which had been purified by electroösmosis. Lime-bonded brick were made for comparison. For the most part the bonding power of the above clays, as far as the compression strength of the green brick is concerned, is in the same order as their alumina content. Ball clays, however, have a very small grain size, whereas fire clays of the type of No. 6 are coarser grained and hence do not have the "spreading power" of the ball clays. Nine series of clay-bonded silica brick, using the same base, *i.e.*, Totley ganister, and of the same grading were made. For comparison purposes, a batch of 2% lime-bonded and a batch with no added bond were made of the same stone and grading. Each series consisted of three batches bonded with the same clay and having 2, 3½, and 5% of bond, respectively. Series X consisted of Totley ganister as base, one batch with 2% lime, and three batches of clay-bonded brick with 2, 3½, and 5% clay, respectively. In this series the variant was the grading. These batches were not so readily made into brick on account of their coarser texture. In Series XII Penwylit stone was used in the place of Totley ganister. Four batches of brick were made having 2% lime, 3½ and 5% clay bond and one with no added bond. Bwlchgwyn silica stone was crushed and graded for Series XIII. The batches made had 2% lime, 3½ and 5% clay bond, and no added bond. In Series XIV two batches of brick in which all the Totley ganister below 30-mesh was replaced by Lynn sand were made. One of these was made with 2% lime bond, the other with 5% clay bond. In both cases the brick were exceedingly difficult to mold and when dry they were still very fragile. The entire absence of impalpable powder in the grading rendered them very tender. The percentage of sand in this series was 63.7. Complete tables of all these series are given. The brick were fired in commercial silica brick kilns. Temperatures were observed with an optical pyrometer during the progress of the firing and the time-temperature treatment was recorded by Seger cones. In order to compare the behavior of the different clay bonds, different kinds of stone, the effect of large and small additions of sand, and the alteration in grading, several tests were applied to the brick. In all variations of bond and grading with a stone, a corresponding 2% lime-bonded batch was made. All the brick in each batch were weighed and their dimensions determined and the average bulk density calculated. Brick were taken from each batch in the green state and tested in compression. In all the cases whole brick were used for compression and transverse strength, thus preserving any effect due to the closer textured skin. The ball clays gave a mechanically strong brick with 2% bond. The strength increased with 3½% bond but did not markedly increase with further additions up to 5%. The fireclay and china clay bonds gave brick which were rather weaker than the comparison lime-bonded brick. For the determination of the transverse strength of the fired brick whole brick were used. These were laid on their 4½-in. faces and supported on knife edges 6 in. apart. The values obtained for this cross-breaking load and for the modulus of rupture are shown graphically in the article. The ball clay bonds gave increasing transverse strength up to 3½%, but the strength decreased with higher proportions. The fire clay and china clay gave a steadily increasing transverse strength with increasing proportion of bond. The porosity was determined on all the batches and the results shown graphically. Though the behavior is somewhat irregular, in general the more aluminous plastic clays give a more rapid decrease in porosity as the percentage of bond increases. This is very marked in the case of Series II. The powder densities of the fired brick are somewhat higher than that normally obtained with lime-bonded silica brick and vary in an irregular manner with increasing percentage of bond. The extreme range, however, is not as large as was to be expected, considering the great difference in properties of the clays used. The whole of Series I to IX comes between the limits 2.41 and 2.465. **III.** *Ibid.*, [38], 56–64

(1928).—Methods of preparation and composition of large batches of brick for works trials are given. The resulting general conclusions are as follows: (1) Clay-bonded silica brick can be made by the same process as ordinary lime-bonded brick. Better and quicker spreading of the clay over the fragments of stone is obtained if the clay "slip" used is deflocculated with sodium silicate. The general properties of the clay-bonded batch are similar to those of the lime-bonded, except that the clay-bonded batch is more sensitive to variations in water content. (2) Under commercial conditions of firing there is very little difference in the rates of inversion of clay- and lime-bonded brick. (3) The refractoriness of brick with $3^1/_2\%$ clay bond is about equivalent to that of 2% lime-bonded brick of the same raw material and grading. The general behavior under load does not appear to differ much from that of the 2% lime-bonded brick. (4) The spalling resistance of clay-bonded brick is better than that of the lime-bonded brick of the same grading. (5) Where brick are exposed to slag or corrosive dust the durability of the clay-bonded is less than that of the lime-bonded brick, especially if exposed to basic-dust. In the roof of the acid open-hearth furnaces no difference is seen in the durability of the clay- or lime-bonded brick, but in the basic-furnace roofs there is a slight difference in favor of the lime-bonded. In electric furnaces there is an increased durability of the clay- over the lime-bonded brick. (6) In coke-ovens the durability of clay-bonded brick is indistinguishable from that of lime-bonded. The trials indicate that both clay- and lime-bonding is equally resistant to salt action and mechanical wear. E.P.R.

Red fire brick. ALFRED B. SEARLE. *Refract. Jour.*, **4** [38], 38 (1928).—Most manufacturers will deny that fire brick can be red, but there is one plant where red fire brick conforming to all the requirements of the standard specifications are produced. The red is not due to the clay, but only occurs when the kiln has previously been used for firing red brick. No matter how carefully the kiln is cleaned, if fire brick are fired after red ones there appears to be enough dust left to stain the faces. On breaking, the normal buff color is revealed. E.P.R.

Refractories for brass foundry furnaces. H. M. ST. JOHN. *Refract. Jour.*, **4** [38], 38–44 (1928).—The refractory problems depend on the type of furnaces and the fuel used. The varieties of furnaces sufficiently important to merit consideration are crucible pit furnaces using coke or hard coal, crucible furnaces using oil or gas, open-flame furnaces using oil or gas, indirect-arc electric furnaces, induction furnaces. The qualities required from the refractory structures in these various furnaces are varied in their nature. Crucible furnaces using solid fuel are of diminishing importance but still melt about 20% of the total foundry melt. Coke is the usual fuel. Refractories come in contact with the fuel but not with the metal. The linings of the pit fires ordinarily are cupola blocks, ordinary firebrick shapes, or monolithic. Silicon-carbide brick are sometimes used. The life of linings varies from 100 to 1500 heats in different plants. The most rapid wear occurs in the ash zone due to fusing of slag and clinkers to the lining. Pit linings should be of great mechanical strength to resist the action of the poker, should be resistant to the siliceous slag, and should not crack. An improvement would be slag-resisting material more refractory than common fire brick. Rammed linings of silicon-carbide mixtures, if skilfully installed, are very durable as are also certain grades of brick containing silicon carbide. Crucible furnaces using oil or gas are melting less than 10% of the total although they are widely used as reserve equipment. In this type the refractories are directly exposed to the flame but not to metal or slags. The destruction of the linings here is due to the cutting action of the flame and to the decomposition of the unburned fuel. The linings of oil crucible furnaces are usually common fire brick or monolith usually silicon carbide. A rammed lining usually outlasts a fire brick about 50%. A glazed surface on the lining before it is

put into service is an advantage. Open-flame furnaces are used, at least partly, in about 50% of the plants. Here the refractories were exposed to direct action by flame, metal, slags, and fluxes. Cylindrical furnaces are usually lined with brick, oval furnaces with rammed linings, or partly with brick and partly with plastic mixtures. The indirect-arc electric furnace has made rapid progress. The lining life of an indirect-arc furnace varies from 400 to 4000. Silicon-carbide refractories are very durable in this type, but must be backed with insulation. Such linings are very resistant to spalling and vapor penetration. Induction electric furnaces are not used extensively for melting foundry red brass. The average lining life is from 700 to 1500 heats. Plastic mixtures of comparatively low refractoriness are used and are quite reliable and long-lived. In the case of electric furnaces the use of costly refractories is economically sound. Under favorable conditions the lining life is long in electric furnaces. Materials used include kaolin-asbestos mixtures, diaspore clays, silicon carbide, sillimanite, and chrome ore. E.P.R.

Refractory materials for electrical metallurgical furnaces. II. ALFRED B. SEARLE. *Refract. Jour.*, **4** [38], 44–46 (1928).—Monolithic or tamped hearths vary greatly in their durability according to the skill used in their construction and in the manipulation of the furnace. For acid lining ganister is generally employed, two grades being available. It is moistened with water, used alone or mixed with dextrin, water glass, molasses, or other binders. Magnesite should be dead-burned or better electrically fused and ground; such magnesite does not shrink on reheating. The purer the magnesite the more durable it is. The hearths of electric furnaces do not as a rule give much trouble, unless too thin. Electric furnace acid lining may be made of fireclay, silica, or sillimanite brick, but if the hearth is of basic material the walls are of the same material, although the lower brick may be magnesite or dolomite followed by two courses of chromite and the upper courses of "acid" material. Chrome brick are necessary to separate the acid and basic brick to prevent fusing at their points of contact. Silica brick are sufficiently refractory, but sensitive to sudden changes in temperature. Electric furnace roofs usually are of silica brick. Temperature around the electrodes is very high so there is always danger of molten silica falling into the furnace. If magnesite roofs would not spall they would be very advantageous. They have been very successful at the Krupp's works. Neither fire clay, nor fireclay-bauxite brick have been successful in roofs, but brick made of bauxitic clay from the millstone grit in Ayrshire has been very satisfactory. Sillimanite also offers possibilities in furnace roofs. One of the least durable parts of the roof is the "bull's eye." Air- or water-cooling the roof is possible. Roofs should not be insulated. Unless the roof reflects heat directly downward it will not last. Roofs should be true hemispheres. The cement or mortar should be the same as the brick. A number of precautions for the selection of refractories for electrical furnace are given. E.P.R.

Chromite in Turkey. ANON. *Refract. Jour.*, **4** [38], 69 (1928).—The Turkish Council of Ministers has granted to the Turkish Mine Co. a concession for 60 years to work the chromite deposits in the Bosular district, in the Vilayet of Brussa, and also those near Kaslik. E.P.R.

Slag and ash-resistant brickworks. C. PRESSWOOD. *Refract. Jour.*, **4** [39], 84 (1928).—Among the several agencies seriously attacking and destroying refractory brickwork, slag and ash are important, and in many furnaces are so active that other agencies can almost be neglected. Slag rarely affects boiler furnace walls, ash often destroys walls of metallurgical furnaces even if they are gas-fired. Both these agencies act chemically and physically. From the physical aspect, slag (a liquid) easily penetrates the pores and joints of brickwork. Chemical action is thereby accentuated, and since the matrix embodying the coarser particles is generally less refractory and re-

sistant than these particles, it is dissolved first, the coarse grains or grog being detached solid. The viscosity of the slag coupled with its "flow" assists in the destruction, and the use of fluxes so essential in metallurgy, whereby the viscosity of slag is lowered, only serves to increase the chemical action between lining and the liquid in contact.

E.P.R.

Refractory materials and carbonizing industries. A. T. GREEN. *Refract. Jour.*, **4** [39], 88 (1928).—In a lecture before the London and Southern District Junior Gas Assn., Nov. 30, 1928, G. suggested that the carbonizing industries pay insufficient attention to the manufacture and performance of refractory materials, considering the extremely important bearing they have on the economics of the carbonization process. Fire clay will still be employed for comparatively low carbonizing temperatures, but for high temperatures silica is not only desirable, but essential. The increase of its thermal conductivity and diffusivity with increasing temperatures, and its under-load resistance to extremely high temperatures, render it paramount. E.P.R.

Cupola refractories. A. B. SEARLE. *Refract. Jour.*, **4** [39], 92 (1928).—The necessary qualities of a cupola refractory are outlined and the best type of fire brick to suit these requirements is described. The properties of various types of refractory brick are discussed. The points to be watched in lining and upkeep are given. With the use of monolithic or stamped linings it is shown that great care must be taken when firing the lining in. For further references see *Ceram. Abs.*, **8** [2], 118 (1929). E.P.R.

Reliable refractories. ANON. *Refract. Jour.*, **4** [39], 96 (1928).—In many metallurgical and engineering operations uniformity and continuity of production are of vital importance, and one factor which is closely associated with these requirements is the character of the refractories. It is well known that no one refractory material is suitable for every kind of service condition. It cannot be too strongly emphasized that accurate knowledge of the working conditions of a refractory, whether used in boiler settings, metallurgical furnaces, gas plants, or cement kilns, places valuable information in the hands of the refractory maker. In the casting of steel ingots direct or in groups from the bottom it is essential that only the very best refractory materials be used. Especially should they be able to withstand the sudden shock of molten steel at very high temperatures, and the erosion which would take place with an inferior article. The Sheffield clays have been found suitable for these conditions. E.P.R.

Refractories and insulating materials displayed. ANON. *Refract. Jour.*, **4** [39], 99 (1928). E.P.R.

Refractory. ANON. *Bull. Assn. Document.*, **18** [133], 10 (1928).—The French Thomson-Houston Co. patented a material resistant to heat, particularly applicable to the construction of deflectors or other elements of protection and having good resistance to intermittent arcs. Silica base compositions have the great inconvenience of becoming covered quite rapidly with a deposit of copper silicate, causing deterioration of the protecting element. A typical composition of the patented material is: zirconia 10 to 75%, lime 5 to 60%, asbestos 20 to 40%; the small proportions of zirconia being mixed with the larger proportions of lime, and vice versa. The mixture of these materials, moistened with water, is compressed, molded, dried, and subjected to a vapor pressure of 8 to 11 kg./cm². for a period of from 6 to 12 hours. E.J.V.

Magnesite industry in Austria. ANON. *Chem. and Ind.*, **47**, 1270 (1928).—Exports to European countries are satisfactory, but there is a drop in exports to the U. S., owing to decreased iron production in America. The Leitendorf, Trieben, and Veitsch works all report satisfactory affairs; Breitenau has opened up again after being closed for a year; plants in Styria dismissed a few workers, but are satisfactorily occupied. The European Magnesite Trust was dissolved in Dec., 1927, but was afterward continued for two years. H.H.S.

Refractories in the gas industry. E. W. SMITH AND H. M. SPIERS. *Chem. and Ind.*, **47**, 1277–84 (1928).—The upward trend in carbonizing temperatures (which may now exceed 1400°C) has resulted in the employment in the hottest zones, of silica brick approximating 95% SiO_2. The requirements of such brick are constancy of volume, freedom from spalling, refractoriness under load, chemical stability, mechanical strength, thermal conductivity, and a good shape and texture. The authors deal in detail with these requirements, especially with regard to the transformations of silica. H.H.S.

Requirements of modern refractory materials. A. T. GREEN. *Ind. Chem.*, **4** [46], 484–89 (1928).—A survey is made of products made of silica, fire clay, magnesite, sillimanite, silicon carbide, alundum, and chromite, as to their behavior in industrial usage, mainly for the open-hearth steel furnace and for electric-furnace linings. The properties noted are refractoriness with and without load, tendency to spalling, thermal expansion, porosity, and true and apparent specific gravity. The influence of carbonizing conditions is considered. H.H.S.

Structure of sillimanite and mullite. W. H. TAYLOR. *Z. Krist.*, **68** [6], 503–21 (1928).—T. describes the analysis leading to the determination of the structure of sillimanite and the relation existing between mullite and sillimanite. A diagram is given of the unit cell of sillimanite. The structure of sillimanite has been determined in order to attempt to find a definite example of the relationship between this crystal and mullite. The special feature of the sillimanite structure is that the replacement of silicon atoms by aluminum atoms would involve only a very slight alteration in the arrangement of the oxygen atoms; this at once suggests a structure for mullite for which some experimental evidence has been obtained. The application of this principle of replacement of silicon by aluminum, to kaolin and to other compounds, is discussed. T.W.G.

Thermal dissociation of dumortierite. N. L. BOWEN AND R. W. G. WYCKOFF. *Jour. Wash. Acad. Sci.*, **16** [7], 178–89 (1926).—Dumortierite is an aluminous mineral with the composition $8Al_2O_3 \cdot 6SiO_2 \cdot B_2O_3 \cdot H_2O$. Small amounts of iron and titanium, whose oxides seem to replace alumina and to impart the commonly observed colors, are usually present. B. and W. studied a dumortierite from Clip, Ariz., whose chemical composition was known. The mineral is of a deep blue color. When heated for a few minutes at 800°C in an oxidizing atmosphere the mineral becomes pure white; after $4^1/_2$ hrs. the powdered mineral shows no sign of sintering, and there is no change in refractive indices. After 4 hrs. at 950°C the fine powder again shows no sign of sintering but a definite change can be observed by means of the microscope. Irregular dark streaks have developed with elongation transverse to the prism, giving a fibrous appearance, but each grain as a whole is still of uniform extinction and negative elongation similar to the original grain of dumortierite. The refractive indices are lowered, γ now being 1.68, whereas it was originally 1.69. Dumortierite is almost completely changed to a material of lower refractive index when held at 1200°C for only 10 min. Each grain still contains small amounts of unchanged dumortierite. After 30 min. at this temperature the mineral is completely transformed into the substance of low refraction, which is made up of fanlike groups of radiating, fibrous structure, the fibers having fairly strong double refraction and positive elongation and having all the appearance, even under the highest powers of the microscope, of a crystalline aggregate made up of a single substance with a mean refractive index of 1.61. When heated for longer periods the only further change is the increasing development of irregular, dark streaks that are probably cracks or voids which do not extend to the exterior of the grain and therefore do not become filled with the immersion liquid. The mean index is 1.61 even after heating for some days at 1200°C. X-ray examination (powder method)

of the decomposition product obtained at 1200° shows all the characteristic lines of mullite. Results of an intermediate character are obtained at temperatures between 950°C (where the first suggestion of change occurs) and 1200°C (where complete transformation to material of low index (1.61) is readily effected). At 1100° the product is not much different from that obtained at 950°. At 1150° after 4 hrs. a small proportion of the dumortierite is transformed into the material of low refringence, and at 1180° after 4 hrs. a large proportion has suffered a like change. The X-ray diffraction patterns of these intermediate products show increasing development of the mullite lines and decreasing effects from dumortierite. After 2 hrs. at 1400°C there is again no appreciable sintering of the powder and under the microscope, at high powers, two substances are definitely made out, one of which seems to be mullite and the other of silica and boric oxide. After 4.5 hrs. at 1500° the powder is very weakly sintered into a mass which readily breaks down again into a powder between the fingers. The microscope shows the same type of decomposition as that obtained at 1400°C. An X-ray photograph of the powder shows all the characteristic lines of mullite well developed. After $^3/_4$ hour at 1550° there is decided sintering to a firm cake and the color is no longer a pure white as it is after heating at lower temperatures but is a pale grayish buff. Under the microscope it is found that definite prisms of mullite have developed, with an interstitial material of low index which is a glass. Definite formation of some liquid is indicated. The behavior of dumortierite on heating is for all practical purposes that of material containing only alumina and silica. The dumortierite contains about 6.7% $H_2O + B_2O_3$ and these are quantitatively expelled at 1500° in 4.5 hours, whereas at 1200° more than 130 hours are required. X-ray powder diffraction photographs have been prepared for the samples heated at various temperatures. Accurate spacing measurements upon the principal powder lines were made by using photographs from samples of dumortierite mixed with NaCl to serve as a standard. The pattern of dumortierite contains many faint lines. From its formula, dumortierite might conceivably be considered as a hydrated mullite, $3Al_2O_3 \cdot 2SiO_2$, in which some of the alumina is replaced by boric oxide but comparison of the powder photographs shows clearly that there is no such relation. The diffraction observations prove that the structure of dumortierite remains unchanged after heating for 4 hrs. at 950°C and 1100°C and that mullite is the chief product arising from heating dumortierite to 1200°C or 1500°C. Dumortierite is to be regarded favorably as a basis for refractory bodies, and, on account of its higher Al_2O_3 content, as having some advantages over sillimanite, andalusite, and cyanite. For refractory purposes, dumortierite may be considered to have the formula $4Al_2O_3 \cdot 3SiO_2$ and its thermal behavior may be read off from the alumina-silica diagram. Though some liquid is formed at 1545°, the amount (4%) is less than that formed from sillimanite, cyanite, or andalusite (14%) so that failure under load at that temperature should be much less notable. With further rise of temperature increase in the amount of liquid is very slow until about 1700° where it amounts for the 4:3 mixture to about 6%. The liquid then increases more rapidly until at 1810° it amounts to about 18%. The 4:3 mixture has therefore only a slightly greater amount of liquid at 1810° than the 1:1 mixture has at 1545° although in the latter case the liquid is more viscous. At 1810°C the 4:3 mixture is abruptly transformed from mullite with a little liquid (18%) to corundum with much liquid (nearly 70%) and all its refractory power disappears. Observations were also made on less pure dumortierite from Nevada. A.J.M.

Calculation of the most economical thickness of insulation. E. Borschke. *Arch. Wärmewirt.*, **9**, 117–20 (1928).—A detailed mathematical discussion, including diagrams to aid in the solution of the equations arrived at. (*C.A.*)

Determining the most favorable wall thickness of industrial furnaces. H. Repky.

Arch. Wärmewirt., **9**, 145–49 (1928).—A mathematical discussion, especially of the case of intermittent use. (*C.A.*)

Constitution of silica brick. K. ENDELL AND E. PFEIFFER. *Ber.*, **91**; *Werkstoff. Ver. deut. Eisenhüttenleute, Sitzb.*, **2**, 8 (1926); *Physik. Ber.*, **8**, 78.—The volume-temperature diagram of the SiO_2 system is constructed by means of data from the literature. Examination is made of 41 different bricks, whose customary physical properties are recorded. Good grades of brick show an elongation of 0.7 to 0.8% up to 300°, 0.9% at 600°, and 1.0% at 800°. Poor grades give 0.4% at 300°, then a strong elongation between 500° and 600°. After heating at 1450°, a good brick does not retain any permanent deformation, whereas a poor-grade brick remains 0.6 to 0.8% deformed. Since the main deformation of good brick occurs below 300°, the heating of coke ovens should be carefully controlled up to that temperature. (*C.A.*)

Testing of refractory materials. HERMANN SALMANG. *Intern. Congress Testing Materials*, **II**, 365–70 (1927).—Toluene is best for true specific gravity. The air-expansion method is best for porosity. Other properties to be tested are soundness at high temperature, spalling during temperature change, heat conductivity, melting point, weakening at high temperature under load and slagging. (*C.A.*)

Recent developments in the testing of refractories. M. C. BOOZE. *Intern. Congress Testing Materials*, **II**, 371–74 (1927). (*C.A.*)

PATENTS

Method of obtaining titanium oxide. REGINALD HILL MONK. U. S. 1,695,341, Dec. 18, 1928. The method of converting refractory compounds of titanium after the elimination of impurities and a large portion of the iron content into water soluble sulphates, comprising mixing the comminuted compound with an alkali-metal sulphate and an acid solvent, heating the mixture at 120 to 300°C, until a solid cake is formed, cooling and crushing the cake.

Arch brick. RALEIGH J. HIMMELRIGHT. U. S. 1,695,459, Dec. 18, 1928. A refractory member composed of laminae of different lengths.

Refractory cement. JOHN W. MARDEN AND HENRY K. RICHARDSON. U. S. 1,695,812, Dec. 18, 1928. A composition of matter comprising thoria, a double halide salt adapted to act as a binder and suspender of the thoria upon the addition of a liquid, and a dry ingredient adapted to precipitate any colloids present in the composition and cause them to coagulate.

Mold for high-temperature casting of refractory bodies. KARL E. PEILER. U. S. 1,696,688, Dec. 25, 1928. The process of making a mold for high temperature casting, that comprises mixing 80 to 85 parts of fused silica, of which a material portion is amorphous, comminuted to at least 20-mesh fineness, with 20 to 15 parts of comminuted lime, adding sufficient water for dry pressing, dry pressing the resulting mixture, and hardening the molded material by heat in the presence of steam.

Furnace wall and brick therefor. OSCAR NYGAARD AND BENJAMIN H. SNOW. U. S. 1,696,812, Dec. 25, 1928. A furnace-wall structure comprising superposed courses of brick, composed entirely of refractory materials, the brick in one course breaking joints with those in the next course, the brick having upright rearwardly projecting portions with the projecting portions of the brick in one course superposed on the projections of the brick in the next lower course, the wall having vertical air passages across adjacent courses, formed by the portions, to permit a vertical flow of air past the rear faces of the brick.

Brick for furnace-wall construction. OSCAR NYGAARD. U. S. 1,696,813, Dec. 25, 1928. A brick for furnace wall construction having a relatively large chamber extending into it from the rear side thereof leaving a relatively thin wall at the front of the brick, the brick being made of nonmetallic refractory material, flanges projecting

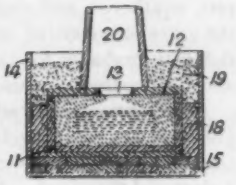
rearwardly from the wall at opposite edges thereof and forming opposite walls of the chamber, the flanges having notches therein provided passages therethrough leading from the chamber to the opposite sides of the brick, and a hole extending through the wall from the chamber to the front face of the brick.

Ladle stopper. CHARLES C. BACON. U. S. 1,696,876, Dec. 25, 1928. A stopper of refractory material having a concavity provided with a thread of refractory material and having a plate washer of spiral form embedded in the wall of the cavity and constituting a part of the thread.

Hollow furnace wall and brick therefor. OSCAR NYGAARD. U. S. 1,697,403, Jan. 1, 1929. A furnace wall comprising front and rear wall sections, the front section including brick having rearwardly projecting upright flanges abutting against the rear section and providing vertical air spaces between the rear section and the main part of the front section, tie brick projecting from the rear section and anchored between superposed flanges of the brick of the front section, the flanges and tie brick coöperating to provide vertical partitions partly separating the vertical air spaces from each other, and the flanges being notched transversely to provide horizontal air passages connecting the vertical air spaces.

Roof arch or wall for combustion chambers. ALFRED V. DE GRAND. U. S. 1,698,395, Jan. 8, 1929. In a structure of the kind referred to, a plurality of elements disposed so as to form a roof, arch, or wall, a supporting structure arranged above the elements, a vertically-adjustable sustaining device on the supporting structure for each of the elements, clevises mounted on the lower ends of the sustaining devices, arc-shaped hangers attached to the elements and projecting upwardly from same, and a pivot pin for connecting each hanger to its coöperating clevis, each hanger having pivot pin holes arranged in an arc so as to permit the element to which the hanger is secured to be adjusted in an arc relatively to its sustaining device.

Casting refractories. CORNING GLASS WORKS. Brit. 298,983, Dec. 12, 1928. Solid cast refractory articles of alumina, silica, zirconia, etc., are formed by pouring molten material into a mold, allowing a portion of the material to solidify and shrink, and feeding additional melt into the mold to compensate for the shrinkage. As applied to the production of blocks for lining glass melting tanks a mold 11 is built up of baked slabs of sand bonded with linseed oil and is surmounted by a top slab 12 provided with a central gate 13 for the entrance of the molten refractory material. The mold 11 is supported within a metal casing 14 by spacing bricks 15, 18 and is surmounted by a font mold 20 which is surrounded by insulating material 19. In operation, the mold is prepared as shown and molten refractory material is poured into the mold 11 through the font mold 20 to a height of about 3 inches in the font mold; before the casting has completely solidified, the font mold is removed and the front formed at the entrance of the mold is broken away; a new cover slab 12 is then placed on the casting and the font mold replaced and a second pouring effected. After the second font has set, the font mold is removed and the font is surrounded by insulating material. After complete solidification, the second font is broken away and any scar removed and the casting is covered with insulating material and set aside to anneal. Articles may be produced at a single pouring provided the thickness of the casting be less than the diameter of the gate.



Terra Cotta

New method of direct firing glazed ceramic bodies. FRED A. WHITAKER. *Jour. Amer. Ceram. Soc.*, **12** [2], 87–95 (1929).—A new method of firing oil is described uti-

lizing long chambers running along the sides of rectangular kilns and in which combustion takes place, the gases emerging through suitable openings and passing through the ware to the flues. In existing installations white glazed ware is being fired direct without a muffle and showing remarkable economy of operation.

Acid-proof brick. ANON. *Brass World and Platers' Guide*, **24** [12], 376 (1928).—The General Refractories Co., Philadelphia, has announced the introduction of a new brick which is intended for use wherever acids are handled. This brick, according to the maker, will resist the corrosive effects of acids of any concentration, including concentrated sulphuric. The brick, known as "Acido," is made from specially selected clays which are treated to produce a dense, impervious body which is thoroughly acid-resistant. The brick are stated to be uniform in quality, size, and shape. They are made in standard 9-in. sizes and all standard shapes. E.P.R.

Composition of ancient Roman pottery and terra sigillata fragments. ADOLF JACQUET. *Keram. Rund.*, **36**, 511–13 (1928).—Analyses were made of fragments of pottery associated with an ancient Roman kiln situated between Nied and Höchst and discovered during excavation (1890–93) to determine whether fragments showed dissimilarities in composition and whether some clay was imported from Italy over the prominent highway that passed near the spot where the excavation was made. Two general types of ware were distinguished (1) pitchers, bowls, etc., made from heavy, unwashed clays, (2) bowls and cups made of washed and purified clays, either unglazed or with a thin glaze. The typical analyses of these two types are as follows:

	(1)		(2)	
SiO_2	71.81		55.47	
Al_2O_3	15.36	21.61	17.85	27.85
Fe_2O_3	3.65		6.56	
Mn_3O_4	2.60		3.44	
CaO	1.38		5.30	
MgO	1.41		5.89	
K_2O	2.48	3.15	4.62	5.31
Na_2O	0.67		0.69	
Bi_2O_3	0.16		0.22	
SO_3	Trace		0.09	
	99.52		100.13	

J. concludes that both types of ware used the same clay, that the clay was dumped into pits, weathered, and washed, and two kinds of clay were obtained. One of these, with the lower SiO_2 content, was used for terra sigillata ware and to it was added a short CaO rich clay probably to obtain a glazelike surface. The clay with the high SiO_2 content and CaO content was used for the lower grade ware. H.I.

Development of fireclay ware. H. OECHELHAEUSER. *Keram. Rund.*, **36**, 537–39 (1928).—The name fireclay ware is applied to sanitary ware which contains a refractory clay grog fired to below complete vitrification and which is covered with an engobe and a glaze and then fired. Attention has been drawn to fire clay for this type of ware because of its many good qualities especially its high stability combined with its white appearance. In spite of difficulties in obtaining satisfactory relations between the expansion coefficients of body, engobe, and glaze, this type of clay is being successfully used in the fabrication of such large objects as bathtubs, toilets, lavatories, etc. For the body the clay substance is introduced as several kinds of plastic clay. Fired materials, such as broken saggers, serve as grog. Three sizes of grog are used, the largest passing through a sieve with 4-mm. openings. The sizes of grog and the relative amounts of different sizes used depends to some extent on the size of the ware being made. The grog is selected for freedom from iron and is used in quantities of from 40 to 55%. The grog must be fired below complete vitrification so that it retains some porosity. The clays

also must be iron-free. After grinding through rolls the clays are made up into a slip and to the slip the grog is added after having been ground and screened. For casting purposes (for which this type of body is particularly suited) deflocculating agents such as sodium carbonate, caustic soda or water glass are added with the mixing water. The slip must be thin enough to pour easily but thick enough so that separation does not take place in the plaster forms. Before casting the slip is run over magnets to remove iron. After removal from the plaster forms the ware is polished with a piece of leather or a polished iron plate, the former being preferable because of the danger of iron flakes from the latter. Drying must be done in a room absolutely protected from drafts. Artificial drying is advantageous. A hard whiteware or a soft porcelain type of engobe is used. The raw materials are ground in a ball mill, the fineness being controlled by regulating the number of turns of the mill. If the engobe is too fine it may split off the ware. The ground engobe is passed through a sieve with 70 meshes per cm. After mixing the engobe with adhesives such as dextrine, glue, or gelatin it is painted on the ware with a broad brush. The consistency must be regulated so that open pores in the body will be filled by the first coat. The second coat may be thicker than the first. The glaze used is either a fritted hard whiteware or soft porcelain glaze. It is mixed with adhesives and applied with a brush, the same precautions being observed as in the application of the engobe. The ware is fired to cones 7 to 10. The usual precautions as to setting the ware in the kiln and the rate and duration of firing, must be taken. H.I.

White Wares

Scratch hardness tests of ceramic materials. LOUIS NAVIAS. *Jour. Amer. Ceram. Soc.*, **12** [2], 69–74 (1929).—Three sets of standards were prepared (1) a set of minerals according to Mohs' scale, (2) a set of steel samples, and (3) a set of Carboloy (tungsten carbide alloy) samples. The sets of standards were compared with each other according to their scratch hardness. Specimens of ceramic materials were then measured for scratch hardness with each set of standards. The results are compared.

Smooth-surface tile. V. S. SCHORY. *Jour. Amer. Ceram. Soc.*, **12** [2], 75–78 (1929).—A series of experiments is described by which a body suitable for the manufacture of smooth-surface tile was developed. The effects of certain raw materials and of the firing conditions are reported.

Pyrophyllite, a new ceramic raw material. G. R. SHELTON. *Jour. Amer. Ceram. Soc.*, **12** [2], 79–82 (1929).—The relationship among the minerals pyrophyllite, kaolinite, and steatite together with a statement of the properties of pyrophyllite are given. The N. C. deposits of pyrophyllite are briefly described. A preliminary report is made on tests now being conducted to determine the possible use of pyrophyllite as a constituent in whiteware bodies.

Haviland china. RICHARD DEMAREST. *Crockery and Glass Jour.*, **106** [18], 94 (1928).—History of Theodore Haviland & Co., makers of china for the world and its kings, is given. Illustrations and descriptions of some of the more outstanding Haviland ware are given. E.P.R.

Efficiency in pottery industry. M. K. ZIMMERMAN. *Crockery and Glass Jour.*, **106** [18], 110 (1928).—Construction of domestic pottery plants today is quite different from former years. Two- and three-story pottery buildings are no longer erected. Buildings of one story are the rule, but they have great length. There is no retracing of steps in the movement of either raw materials or finished product. Materials enter the plant at one part of a modern pottery, and there is a steady forward movement, all on the same floor through to the packing and shipping departments. The Homer Laughlin China Co. erected the first of these modern factories at Newell, W. Va. Instead of kiln tops extending through the roof, only one mammoth stack appears above the roof line.

Instead of heating these new plants with steam as has been the custom, waste heat from the tunnel kilns is utilized, another step forward in factory improvement. The development of a number of modern pottery plants is given. E.P.R.

Chinese porcelains. LULA C. FITZPATRICK. *Crockery and Glass Jour.*, **106** [18], 114 (1928).—Porcelain was invented in China. This was acknowledged in England by the adoption of the word "china" as equivalent to porcelain. Porcelain which the Chinese define as, a hard, compact, fine-grained pottery is distinguished by the clear, musical note which it gives out on percussion, and the test that it cannot be scratched by a knife. Porcelain is a white, translucent, hard paste, not to be scratched by steel, and when broken shows a fine grain and brilliant aspect. If the paste or composition has all the properties, with the exception of translucency, it is earthenware. Pottery was, doubtless, the earliest material from which vessels were made for meat offering, and containers for wine, for ancestral worship, and it has been retained ever since in the ritual of the poor. The date of the introduction of glaze into the Chinese pottery field is unknown although it is very evident that it made its appearance before the use of glass. E.P.R.

Origin of warpage and cracks in porcelain. M. FLEROFF. *Ber. deut. keram. Ges.*, **9** [11], 596–603 (1928).—The arrangement of the particles of clay in a body produced by the action of the pug mill and the effect of the shape of the body upon the shrinkage of the body are made the basis of an investigation of the origin of warpage of porcelains. F.P.H.

New process of casting dinnerware doubles sagger output. ANON. *Ceram. Ind.*, **12** [1], 70 (1929).—Probably the greatest expense in the manufacture of dinnerware is the bisque firing and by the use of this new method the output of every sagger is said to be increased from 100 to 500%. The significance of this economy can be readily appreciated by any potter. By this process 99% of the clay prepared is used in the manufacture of the ware whereas under the old method approximately 4 times the amount of clay necessary to mold a cup is used by the jiggerman, and 75% is returned to the slip house for re-making. By the new method cups are molded with the handles on them and come from the mold practically finished. Great flexibility in production is claimed for this process, as one unskilled man makes every piece in the dinner set. To speed up the production of any particular class of merchandise it is not necessary to alter the personnel of the factory as this one unskilled laborer can produce at will any quantity of any desired article without diminishing his production. F.P.H.

Fiftieth annual meeting of U. S. Potters Assn. ANON. *Ceram. Ind.*, **12** [1], 73–76 (1929).—A. V. BLEININGER presented the outstanding features of the committee report. The Bureau of Standards has done considerable work on feldspars covering their physical constants, how they expand, why some expand more than others, and the effect of different feldspars on body and glaze. Permanent change in volume as well as thermal or temporary expansion were being thoroughly investigated, data of the greatest importance for both vitreous and semivitreous ware being gathered. Investigation of the modulus of elasticity was nearing completion. Properties of English china clays, the thermal expansion of glazes, the phenomena of crazing and shivering, the exact expansion caused by different oxides and their arrangement in that order, were all referred to as work now in hand, that, when finished, would be a permanent contribution to the industry's technical knowledge. The marked variation of the tensile strength of glazes, one showing 4500 units as against the 9700 units of another, prove that some glazes are twice as strong as others. Manufacturers of semivitreous ware have learned that crazing of ware develops while in storage on the Pacific Coast, and a chemical combination of the atmospheric moisture and the body is suspected to be the cause. A bisque body with 9% absorption takes up 0.16% from the air. This action may be accelerated by the hot water used in dishwashers. The Bureau is already striving to find a remedy. F.P.H.

Résumé of conditions in Ohio pottery district. ANON. *Ceram. Ind.*, **12** [1], 84 (1929). F.P.H.

Porcelain factory of Sèvres. GOLDA M. GOLDMAN. *Ceram. Age*, **12** [2], 43–47 (1928).—As a result of the granting of semi-independence to the porcelain factory of Sèvres, Royal Sèvres porcelains will enter into direct commercial competitions in fields in which they have long been acknowledged as supreme works of art. After outlining the history of porcelain in general, G. describes the development of the art of manufacturing procelains in France, the founding of the Sèvres factory, its present staff and manufacturing methods and the artistic and commercial value of the products. A.E.R.W.

Buffalo pottery. J. B. NEALEY. *Ceram. Age*, **12** [2], 52–54 (1928).—The Buffalo Pottery, started 27 years ago, making plain and decorated vitreous china, is one of the largest in its line in the world today, having an average output of 10,000 doz. dishes a week. The handling of the raw materials, body preparation, jiggering and casting of ware, firing, glazing, and decorating are described in detail. The bisque kilns are fired with coal. Much of the ware is decorated before being fired in the glost kilns. Several of the glost kilns are fired with gas. A comparison is made of their operation and costs with those of the kilns fired with coal. A.E.R.W.

Tile and other building products. G. D. HAINES. *Ceram. Age*, **12** [2], 55–59 (1928).—H. replies to an article by D. P. Forst, entitled "Wall Tiles Essentially from Clay" (*Ibid.*, **11** [5], 180 (1928)). The question is whether or not a product should be named in accordance with its use or with the material from which it was made. H. considers the former to be the correct procedure, and gives quotations from dictionaries, cites instances and refers to the classification adopted by Sweets' Agricultural Catalog or the Thomas Register of American Manufacturers as evidence. The Thomas register lists tile as a class with 51 subdivisions of tile made from various materials and for various purposes. H. claims that the coining of the word "Porstelain" was not an effort at deception, and gives reasons for its use. A.E.R.W.

Exports of porcelain from Czechoslovakia, 1923–1927. ANON. *Keram. Rund.*, **36**, 530–32 (1928). H.I.

PATENTS

Insulator. WALTER T. GODDARD. U. S. 1,695,458, Dec. 18, 1928. The method of connecting an insulating unit to an adjacent member which consists in assembling the unit and member in nested relation with spacing means therebetween, and finally connecting adjacent surfaces of the unit and member at spaced intervals by pouring molten metal therebetween.

Insulator. FRANZ REITER. U. S. 1,695,858, Dec. 18, 1928. An insulator comprising a dielectric member including a body portion having a portion projecting therefrom and a portion projecting laterally from the projecting portion, and a composite structure including a divided inner ring element surrounding the first projecting portion, an outer element having a single integral ring portion adapted to pass over the lateral projection and to closely fit in position around the divided inner ring element, and a member extending longitudinally between the rings and having laterally extending portions for holding the rings together.

Device for cutting holes in insulators. MINOR F. H. GOUVERNEUR. U. S. 1,697,422, Jan. 1, 1929. In a device of the character described, a relatively stationary support adapted to be disposed upon an insulator in plastic condition, the support having an open portion exposing the material of the insulator, a guide carried by the support, and a cutter movably mounted upon the guide and movable through the open portion and along a curved path through the material of the insulator to form a curved passage therein.

Method and device for cutting holes in insulators. MINOR F. H. GOUVERNEUR. U. S. 1,697,423, Jan. 1, 1929. In an insulator hole cutter, a stationary support, means for mounting an insulator temporarily thereon, a movable support swingable into engagement with the insulator, and a cutting mechanism carried by the movable support adapted to be brought into engagement with the insulator and forced therethrough in a curved path.

Hole-cutting machine. STEWART L. MOORE, JR. U. S. 1,697,434, Jan. 1, 1929. In a machine of the character described, the combination of a supporting structure, means for temporarily mounting an insulator thereon, oppositely arranged curved cutters, and means for moving them in a curved path through the material of the insulator for forming a curved passage therein.

Hole-cutting machine. STEWART L. MOORE, JR. U. S. 1,697,435, Jan. 1, 1929. In a machine for cutting curved passages in insulators, a support adapted to sustain an insulator temporarily thereon, a relatively stationary frame, curved tubular cutters carried by the frame, means for forcing the cutters in a curved path through the insulator and into end-to-end relation, and means coöperating with the cutters for removing therefrom clay accumulating therein during their movement through the insulator.

Mold-conveying and pottery-fabricating mechanism. WILLIAM J. MILLER. U. S. 1,697,993, Jan. 8, 1929. In a pottery machine, and endless flexible conveyer for molds, means for propelling the conveyer, and means adapted to intermittently travel with the conveyer to coöperate with the molds.

Spark plugs. G. T. WILSON. Brit. 298,803, Dec. 12, 1928. A lens or window is mounted at the outer end of the tubular conductor and allows the ignition spark and the combustion flame to be examined. Porcelain, mica, and steatite are mentioned as insulating materials and are conically seated in the plug casing and gland. The inner part of the tube carrying the terminal may be separable from the remainder.

Electric insulators. STEATIT-MAGNESIA AKT-GES. Brit. 299,032, Dec. 12, 1928. In an insulator in which the hanger is positioned in the insulator cavity by flexible holders inserted between the hanger and the insulator wall, the flexible holders are now bent, to prevent swinging of the hanger, so that portions of the holders form abutments for the hanger shanks.

Equipment and Apparatus

Chromium plating in wider use for resistance to wear. W. BLUM. *Abrasive Ind.*, **10** [1], 12–14 (1928).—Chromium plating owes its application to mechanical equipment primarily to its hardness, as exhibited in its resistance to abrasion. The chief limitation in the use of chromium for such purposes is its brittleness, which may cause it to crack and flake when deformed. The most successful mechanical uses of chromium are upon measuring instruments such as gages, the service of which often is multiplied several fold. Upon forming and molding dies it is generally satisfactory and beneficial, especially if the conditions do not involve too severe impacts. Upon cutting tools it is of doubtful value, though in numerous applications it has proved successful. Upon moving parts of machinery few successful applications have been noted, but these indicate that with further study many such uses may be developed. Chromium plating is not a panacea for wear. An everlasting tool or machine is as visionary as perpetual motion. Chromium plating has, however, solved many machine-shop problems, reduced costs of operation, and improved the quality of the products. E.P.R.

Electric foundry screen. ANON. *Brass World and Platers' Guide*, **24** [9], 281 (1928).—An electric foundry screen which has the advantage of mobility, has been designed and placed on the market by the Deister Concentrator Co., Fort Wayne, Ind. E.P.R.

Instrument to measure fuel waste. ANON. *Brass World and Platers' Guide*, **24** [10]. 312 (1928).—An electrical apparatus by means of which an accurate check can be kept on the amount of fuel that is wasted in furnaces, boilers, etc., by being allowed to pass up flues and smoke stacks, has been placed on the market by the Uehling Instrument Co., Patterson, N. Y. The apparatus, which is known as the "Electrically Operated Apex CO_2 Recorder," indicates the proper air supply needed for complete combustion of fuel used in firing steam boilers. E.P.R.

Crushing and grinding studies of quartz. JOHN GROSS AND S. R. ZIMMERLEY. *Cement, Mill, and Quarry*, **33** [1], 41–46 (1928); see also *Ceram. Abs.*, **7** [3], 180; [12], 874 (1928). E.P.R.

Tungsten carbide: a new material. SAMUEL L. HOYT. *Trans. Amer. Soc. Steel Treating*, **14** [5], 695–718 (1928).—The use of tungsten carbide as a tool material is described. In tool form it has a Brinell number of over 2000 with half the strength of high speed steel and is capable of scratching sapphire. Tests on making quenched high speed steel, glass, hard porcelain, Hadfield's manganese steel, and abrasive compounds are described. A number of applications are described to show the type of performance obtained. E.P.R.

The air-lift as a chemical engineering appliance. N. SWINDIN. *Chem. and Ind.*, **47**, 1345 (1928).—The air-lift will find increasing use in the acid industries because its simplicity permits the use of the new acid-resisting materials. It may be applied to pumping hot acid-brine, circulating molten metals, raising water heated by submerged flame, or emptying tanks in which a bottom outlet is not desirable. H.H.S.

Separation of solids from liquids. ANON. *Chem. and Ind.*, **47**, S.,*1–32 (1928).—A review of modern plant and appliances made by firms in U. S., Great Britain, Germany and France, is divided into five groups: (1) Gravity or sedimentation, 12 firms; (2) centrifuges (an artificially intensified development of the first group), 8 firms; (3) filtration by percolation or obstruction, 28 firms; (4) evaporation, 8 firms; (5) drying, 23 firms. A sixth group, electric and magnetic deposition, is mentioned but not described. H.H.S.

Mathematical theory of filtration. A. J. V. UNDERWOOD. *Ind. Chem.*, **4** [46], 463–66 (1928).—The basis of the mathematics of filtration is Poiseuilles' equation for the flow of liquid in a capillary, $V = \pi r^4 P/8\eta l$. A filter-cake consists of a number of capillary passages, but they are variable in diameter and length. The filtration problem is also complicated by the cloth, and by the compressibility of the sludge. Equations are adduced from which the final pressure required to filter a given volume at a given constant rate, and the time required for the filtration, can be found. H.H.S.

The "ter Meer" automatic centrifuge. G. TER MEER. *Ind. Chem.*, **4** [46], 490–91 (1928).—M. claims that the machine described, with illustrations, is the first centrifuge to be constructed for continuous operation. Filling, whizzing, and emptying of the machine are all effected without varying the speed or rotation. H.H.S.

Purpose of closed-circuit fine grinding in the cement industry. A. ANABLE. *Rock Prod.*, **32** [1], 66–72 (1929).—Closed-circuit grinding, the present approved method of grinding metalliferous ores as well as many nonmetallics, may be defined as that method of reduction in which the mill is operated in closed circuit with a classifier, which overflows to subsequent treatment only that portion of the mill discharge which has been reduced to the fineness required. That portion of the mill discharge which is returned to the mill by the classifier is called the circulating load and may be built up to several times the new feed to the mill. The control of particle size is centered at the classifier, not at the mill. Not only can the classifier be relied upon to grade the mill discharge accurately at any mesh from 20 to 325, but it permits the mill to be fed at such a rate

*Chemical Engineering Trade Supplement.

and loaded in such a manner that large savings are effected (1) in power, (2) in wear on mill liners, and (3) grinding media, which determine largely the unit cost of grinding. The equipment used in closed-circuit grinding consists of a cylindrical wet-grinding mill, a classifier, and two launders or troughs, one conveying the mill discharge to the feed end of the classifier and the other conveying the oversize discharge of the classifier to the feed box of the mill. The mill is equipped with a spiral scoop feeder, which picks up new feed and classifier discharge from a rectangular box, and feeds it into the mill through the hollow feed trunnion. Water is added in this box to bring the feed to the proper moisture content for efficient grinding. The classifier overflows a uniformly fine material, suspended in several times its weight of water. F.P.H.

Improved mercury-contact manometer. ANON. *Engineer*, **145**, 181–82 (1928).—Numerous diagrams and a complete description are given. This type is particularly suitable for steam flow measurement. As the resistance coil is always in mercury, no electrical make or break is involved and a continuous graduation is obtainable. The instrument is independent of voltage alteration and of static pressure, the latter because both ends of manometer circuit are always at the same pressure. It can be used for measuring the flow of liquids. L.A.P.

Three-phase turbo-alternator. S. PARKER SMITH. *Engineer*, **145**, 366–68, 402–404 (1928).—By reducing losses and insuring uniform cooling, the designer has been able to use his material economically. This and other advantages were gained without sacrifice of reliability. L.A.P.

Failure of wrought iron chain. H. J. GOUGH AND A. J. MURPHY. *Engineer*, **145**, 468–70 (1928).—Excluding failures due to such obvious causes as overloading, defective chemical composition, or bad workmanship in manufacture, the failure of wrought-iron chain and cable may be caused by (1) a brittle state due to overheating during one of the stages of manufacture; (2) progressive deterioration of the weld induced by service shocks and strain (this condition cannot be detected by the usual method of test or by visual inspection); or (3) interlink action, *i.e.*, hammering of chain on ground, snatch loading, rattling through house pipes, battering on chain wheels, etc. The third cause produces a decrease in ductility of the iron at the surface. The ductility of the iron core beneath surface remains unchanged and this difference in ductility between surface and core iron causes most of the failures. Heat treatment, either annealing at a dull red heat or normalizing at 1000 °C will restore chain to its original condition of ductility throughout. L.A.P.

Third report of wire ropes research committee. W. A. SCOBLE. *Engineer*, **145**, 495–96 (1928).—The third report contains final conclusions of an extensive investigation covering a period of more than 8 years. Twelve wires to a strand with a fiber core was considered best when associated with Lang's lay. Ordinary lay was best for 19-wire strands 12 on 6 on 1, except on the pulley of 850-wire diameters. A soft core wire in 7-wire strand is undesirable for rope of high-tensile wire used on small pulley. A pulley of less than 300-wire diameters misused a rope which lasted only while ductility of wire was being destroyed. The tensile strength of a wire was reduced 18% by severe lateral pressure. A considerable number of twists has no effect on behavior of wire under tension or tension with repeated bending over pulleys, but a maintained torque weakens a wire in tension. The high tensile strength given to wire by drawing has but little effect on its fatigue strength. Best indication of wire rope service is indicated on basis of sum of tensile and bending stresses, such being within fatigue range. If pulley or drum is very large, safety factory may be used. L.A.P.

Fatigue-resisting properties of carbon steel. ANON. *Engineer*, **145**, 512–13 (1928).—The behavior of a mild steel under fatigue stresses was tested over a practical range of temperatures, based on fatigue experiments conducted at the National Physical

Laboratory on normalized 0.17% carbon steel. The practical use of results depends on their correct interpretation, and hence a knowledge of the yield-points and of the limiting creep stresses at different temperatures is very necessary. This information is given. L.A.P.

New and old methods of babbitting bearings. A. B. NEWELL. *Power*, **67** [11], 468–70 (1928).—With reference to internal combustion engines, N. points out defects in old style of babbit bearings, explains the necessity of proper oil grooves, and gives various advantages of centrifugal cast bearings. L.A.P.

Use of the interferometer in scientific and technical work. E. BERL AND L. RANIS. *Fortschritte Chem. Physik physik. Chem.*, **19**, 1–52 (1928).—A comprehensive description of gas and liquid interferometers and their uses in physical and chemical measurements. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Tunnel kiln refractories plant. B. E. WHITESELL. *Jour. Amer. Ceram. Soc.*, **12** [2], 96–106 (1929).—Salina Plant of the Kier Fire Brick Co. where all the ware is fired in two hand-fired car-tunnel kilns is described. Some of the steps taken in changing the old plant to the new, the present plant layout, the method and procedure in the manufacture of the different shapes, capacities of the machines, etc., are described.

Completely automatic decorating tunnel kiln. JOHN T. JANS. *Jour. Amer. Ceram. Soc.*, **12** [2], 107–10 (1929).—A continuous decorating kiln is described which is completely automatic in temperature control and ware movement. This paper deals chiefly with the automatic ware movement, which is achieved by mechanical operation of the two four-way valves, through which oil is supplied to ten hydraulic cylinders which open and close the doors, move the transfer cars on each end of the kiln, and move the ware cars through the kiln and down the loading track. An electric repeating contact clock determines the schedule upon which the kiln operates.

Downdraft tunnel kiln. ELLSWORTH P. OGDEN. *Brick Clay Rec.*, **74** [1], 39–40 (1929).—A description of a new tunnel kiln designed and built by Wm. Drayton, manager of the Greendale Brick Co., Greendale, Ohio. Three kiln cars approximately 6 ft. wide and 10 ft. long constitute a unit and are followed by a "damper" car. There are seven damper stations at intervals throughout the length of the kiln, and so spaced that they register with the damper cars. After the kiln has been "pushed down" the dampers at the several stations are shoved in through slots in the side walls and crown of the tunnel until they contact with the damper cars. The damper cars are shorter than the others and are built up to a width and height equal to the setting. Thus when the dampers are shoved in, the longitudinal travel of the gases is effectively obstructed at intervals throughout the length of the tunnel. A system of flues in the floor of cars, running lengthwise and communicating with an upshoot duct in the structure on the damper car completes the scheme for carrying the gases through the tunnel in an undulating course very similar to that of the continuous chamber kiln of the Youngren or Shaw type. This type of kiln, because of its downdraft principle, and its unit control, can be successfully built for capacities up to 50,000 bricks per day, and gives promise of being well adapted to the firing of vitrified paving brick, a performance that it is believed has not been accomplished on a commercial scale in a railroad-tunnel kiln. It has been demonstrated that in this kiln one section (10,800 bricks) can be successfully flashed without discoloring the brick in the succeeding sections. E.J.V.

Electric furnace temperature control. ANON. *Glass Ind.*, **10** [1], 21 (1929).—Among the new research developments of the General Electric Co. during the past year was the adaptation of a thyratron tube to furnish temperature control. The temperature of the furnace is measured by a thermocouple or resistance thermometer connected to the grid circuit of the thyratron in such a way that, when the temperature is below

the desired point, the thyratron carries current sufficient to operate a contractor requiring two or three amperes. In the past, very delicate mechanical devices have been used as relays to enable the heavy furnace currents to be controlled from the extremely minute currents from thermometers. The thyratron supplies the most sensitive relay means yet found for amplifying these feeble impulses to control the large amounts of power used for furnace heating. E.J.V.

Pacific Coast plants using gas for fuel. C. W. GEIGER. *Brass World and Platers' Guide*, **24** [6], 187 (1928).—Many foundries and other metallurgical works find gas best for core ovens and furnaces. E.P.R.

Steady growth in use of electric furnaces. ANON. *Brass World and Platers' Guide*, **24** [9], 277 (1928).—Interesting information with regard to the use of high frequency electric induction furnaces has been prepared by the Ajax Electrothermic Corp., Trenton, N. J., makers of Ajax-Northrup electric furnaces, and a division of the Ajax Metal Co., Philadelphia, Pa. E.P.R.

Submerged flame combustion. N. SWINDIN. *Ind. Chem.*, **4** [46], 467–71 (1928).—An account of the nature of flame and the mechanics of combustion, and of the conditions necessary to keep a flame burning in an inert atmosphere or liquid, with illustrations of various burners now on the market. H.H.S.

Coal pulverization. P. V. VERNON. *Engineer*, **145**, 176–77 (1928).—Theoretical vs. actual energy expenditure in pulverizing is discussed. Seemingly unimportant changes of design have resulted in reducing the power required to less than one-half its original value before such changes were made. In process of air separation, individual particles may pass back and forth through pulverizer to separator many times with consequent waste of energy. The speed of the coal must be less than that of the air carrying it. It is possible to attain an efficiency of 1% or more in pulverizing. L.A.P.

Combustion control formula. E. A. UEHLING. *Power*, **67** [6], 242–44 (1928).—Computations in deriving a bonus system, beneficial both to employer and employee, are given. The analysis of the heat-loss components furnish necessary data for such computations. *Ibid.*, **67** [8], 322–24 (1928).—U. compares the analytic method of controlling boiler operation with the mechanical method and with the synthetic method. The various advantages and disadvantages are discussed. The mechanical method should be supplemented with multiple draft gages, CO_2 recorder, and pyrometer. L.A.P.

Design and application of traveling-grate stokers. T. A. MARSH. *Power*, **67** [8], 328–31 (1928).—Types of stokers most suitable for various fuels are described. Test results are given with various fuels burned on natural-draft traveling stokers and on the basis of these results M. concludes that the natural-draft chain grate has a definite field. L.A.P.

Burning pulverized lignite in a Texas power plant. L. H. MORRISON. *Power*, **67** [10], 410–13 (1928).—M. gives an account of the coal-handling equipment of the Trinidad plant, results obtained with pulverized lignite, and operating experiences in drying and handling this fuel. Excellent furnace results were finally obtained. L.A.P.

Graphs that save calculation of boiler stack draft. C. H. BAKER. *Power*, **67** [13], 550–52 (1928).—Graphs are presented to enable the engineer to determine draft with greater ease than that experienced in use of empirical formulas. L.A.P.

Progress in burning coal. A. G. CHRISTIE. *Power*, **67** [15], 658–60 (1928).—Interesting conclusions are drawn concerning probable future trends. Furnace sizes for stokers and for powdered coal will not be decreased and may even be increased by various means. The use of preheated air will be extended. New furnaces will aim to secure the highest possible furnace temperatures to assure rapid and efficient heat transfer. Water-cooled walls to permit high furnace temperatures will be used to an

increasing extent. Improved drying and pulverizing methods, mixing burners to secure the best degree of turbulence in a water-cooled furnace, and more intense heat evolution per cu. ft. of furnace volume, will characterize future pulverized coal developments. L.A.P.

Water and coal as sources of power: solid fuels. A. A. POTTER AND H. L. SOLBERG. *Power*, **67** [19], 802–805; [21], 905–907 (1928).—Systematic classification of fuels is given dealing with their availabilities, selection, storage, properties, and utilization. L.A.P.

Principle of coal pulverizer. J. K. BLUM. *Power*, **68** [3], 100–103 (1928).—The fundamental principles involved in the successful and economical performance of coal pulverizing mills are analyzed and their application described. L.A.P.

Analysis of solid fuels: determination of heating value. A. A. POTTER AND H. L. SOLBERG. *Power*, **68** [3], 105–107 (1928).—P. and S. explain use of chart, appearing in Bur. Mines, *Tech. Paper*, No. 93, for obtaining ultimate analysis of coal from volatile matter of ash and moisture-free coal. How the heating value of ash-, moisture-, sulphur-, and nitrogen-free coal can be evaluated is explained. L.A.P.

Hotel bisque china fired in tunnel kiln. ANON. *Ceram. Ind.*, **12** [1], 62–66 (1929).—A description is given of the methods and equipment in use at the plant of the Shenango Pottery Co. F.P.H.

Savings with newly developed kiln. ANON. *Ceram. Ind.*, **12** [1], 66–67 (1929).—Construction and operating results of a new type of china kiln installed in an English pottery is described. The inventor, who is Chairman of the Technical Branch of the China Mfrs. Federation, has carried out extensive tests in the firing of both bisque and glost ware in the new kiln, which is one of four at the pottery. The kiln embodies a new principle of firing, the heat being drawn horizontally across the oven through perforations in a central stack. The new construction greatly reduces the period of firing, equalizes the heat in all parts of the oven, and effects considerable economy in fuel and saggers. The main features of the new kiln are as follows: much smaller and more manageable than the ordinary type of beehive kiln; is 11 ft. 3 in. in diameter, little more than 8 ft. to the shoulder, and holds 525 normal saggers, representing approximately 1300 dozens of ware; and has only 4 fire holes. Instead of having flues under the bottom of the kiln, there is a solid base, with the single exception of a flue which leads to the chimney. There is also a solid crown, except for the cooling damper, which occupies the position of the crown damper in the ordinary beehive kiln. The mouths of the kiln are small, and the flame enters through two flues which lead from the side of each fire-mouth. F.P.H.

Gas burner design. B. P. DAHLSTROM. *Ceram. Age*, **12** [1], 21–23 (1928).—The object of any burner is to mix gas with the required amount of oxygen to produce complete combustion. D. gives a survey of the superficial rules that have been developed in the last 25 years. The three main classes: atmospheric, two-pipe systems, and high-pressure gas systems are considered. Atmospheric burners burn the gas at main pressure, about 3 to 4 inches of water. The principle is the same as that of the original Bunsen burner. Ordinarily the velocity of the gas is not sufficient to entrain enough air so some secondary air is required. D. lists the factors to be considered in the design of an atmospheric burner and gives desirable characteristics as follows: (1) large rate of consumption, (2) maximum air entrainment, (3) uniform flame height, (4) wide range of flow rates, (5) no flashing back, (6) no blowing off. D. works out a specific problem to illustrate the principles. Recent developments are multi-tube burners, ring burners, and burners equipped with Venturi mixing tubes. Blast burners of the two-pipe system use gas at atmospheric or main pressure and air at pressures from a few ounces to 2 lbs., introduced as primary air. A typical design problem is worked out. Of recent develop-

ment is the automatic valve using a diaphragm governor on the gas inlet. This produces a uniform flame character, regardless of the amount of mixture which is passing. High pressure systems use gas at 3 to 15 lbs. pressure. The high velocity of the gas enables it to entrain all the air needed for combustion. A.E.R.W.

Tunnel kilns operate continuously for more than three years. ANON. *Ceram. Age*, **12** [2], 56–58 (1928).—Two tunnel kilns in the Thos. Maddock's Sons. Co., Pottery at Hutchinsons Mills, near Trenton, N. J., were closed down after three years and four months of continuous operation, primarily for thorough inspection. They show a remarkable condition of maintenance and only a few minor repairs were required. It was stated at the plant that the kilns are good for 25 years. The maintenance cost of the cars and their superstructure, dependability, uniform results, construction, and layout are discussed. The savings in upkeep of cars and superstructures over the previous methods of using saggers as ware supports has been well above 90%. Photographs of various parts of the kilns after shutting down are shown. A.E.R.W.

Industrial furnace design. R. S. WILE. *Ceram. Age*, **12** [2], 58–59 (1928).—Certain phases in production in the ceramic field require modernization, notably firing. Firing, the very heart of the industry, is still being conducted along the same crude and wasteful lines employed many years ago. W. states that great heat savings can be made by (1) reducing stack losses and (2) using tunnel kilns. Recuperators can be used for the first process. Tunnel kilns should be designed to accommodate the minimum production that is apt to be encountered during the normal business cycle. Peaks can then be taken care of by means of periodic kilns. In the manufacture of terra cotta it has been found necessary to use a muffle in the tunnel in order to gain the color uniformity that is desired, but in every other case the direct-fired kiln is better and more efficient.[1] Coal should always be converted into gas to permit better temperature and atmosphere control. Oil, when fired longitudinally, also allows good temperature control. The design of tunnel kilns and the application of gas to tunnel kilns is discussed in detail. A small tunnel kiln 35 to 40 ft. long is now coming into use. A.E.R.W.

Application of gas in industry. JEHRINGEN. *Gas und Wasserfach*, **71** [45], 1090–95 (1928).—General discussion of annealing ovens of the periodic and tunnel type. Illustrated. T.W.G.

Apparatus for measuring pressure and quantity of gas. M. SCHAACK. *Gas und Wasserfach*, **71** [47], 1137–43 (1928).—Dynamic and static pressure and frictional resistance in apparatus are discussed and illustrations given of various meters and gages based on various principles. T.W.G.

Influence of steam and hydrogen on the burning of carbon monoxide. H. B. DIXON. *Nature*, **122**, 805 (1928).—The rate of flame propagation in mixtures of carbon monoxide and air is increased by the addition of hydrogen or steam. A maximum rate is obtained by the addition of 5–6% of either of these gases. The hydrogen, however, is more effective than the steam in increasing the rate of flame propagation. C.R.A.

BOOK

Technology of Low-Temperature Carbonization. FRANK M. GENTRY. Williams and Wilkins, Baltimore, 1928. Price $7.50. Reviewed in *Min. and Met.*, **10** [265], 47 (1929).—This is the first book published in America dealing exclusively with this subject. It concludes with a chapter devoted to revenue from operation, capital and operating costs, markets for products, freight rates, and other economic considerations, and will rank with H. C. Porters' "Coal Carbonization," as the two best books on the subject. The first chapter is an interesting historical sketch (but no mention is made of the first British patent, issued in 1590, for refining "sea coals" by coking them), and an

[1] Abstractors note: One company making both types of kilns does not agree with this statement.

unusually complete list of the chemical products identified in the products of low-temperature carbonization is a noteworthy feature. More space might well have been devoted to coal as the fundamental in the operation. F.P.H.

PATENTS

Method of and apparatus for gasification. PHILIP D'H. DRESSLER. U. S. 1,698,493, Jan. 8, 1929. The method of distilling coal in a continuous tunnel kiln comprises passing coal through the kiln passageway, transmitting heat to the coal by circulating the kiln atmosphere through a space partially separated from the passageway and wherein the circulating atmosphere is heated, returning the heated atmosphere to the kiln passageway, and mixing a decarbonizing fluid with the portion of the kiln atmosphere passing through the separated space.

Tunnel kiln. GEORGE W. BOOTH. U. S. 1,698,700, Jan. 8, 1929. The combination of a tunnel kiln; a separate drying chamber; a distributing air passage formed in the wall of the chamber extending longitudinally thereof; an air passage arranged adjacent the distributing passage divided into sections, each section communicating with the distributing passage and through a longitudinal series of openings with the interior of the drying chamber; a moist air flue extending longitudinally of the kiln and communicating with the interior of the drying chamber at different points in its length; dampers controlling the communications between the distributing passage and the sections of the sectional passage; and means for drawing air through the passages, chamber, and flue.

Geology

Potash in 1927. A. T. COONS. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 43–50 (1927).—Production of potash in the U. S. during 1927 showed an increase over 1926 of 66% in crude potassium salts and of 86% in the potash (K_2O) content. The average per cent of K_2O in the salts produced was 56.6 in 1927, as compared with 50.4% in 1926. Sales of crude potassium salts in 1927 were 84% more and the potash content of the material sold 98% more than in 1926. The total value of the potassium salts sold in 1927 was 126% more than in 1926 and the value per unit of 20 lbs. was 49¢ as compared to 43¢ in 1926. The consumption of potash in the U. S. in 1927, as indicated by the imports, plus the sales of domestic products was 825,319 short tons of material valued at $20,817,951. Statistics on potash materials imported into the U. S. in 1927 are included. R.A.H.

Silica in 1927. E. R. PHILLIPS AND J. A. DORSEY. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 51–55 (1927).—The production of quartz (crude and ground) from pegmatite dikes, from veins, and from quartzite decreased 20% in quantity and 29% in value in 1927, as compared with 1926. Ground sand and sandstone increased 2% in quantity but decreased 1.6% in value. Tripoli decreased 17% in quantity and 15% in value. The states from which there are producer and consumers of quartz, ground sand, and sandstone are discussed. A review of imports of silica materials is included. R.A.H.

Feldspar in 1927. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources of the U. S.*, Part II, pp. 57–65 (1927).—During 1927, the feldspar industry, judging by the volume and value of business done, retrogressed slightly. The total production of crude feldspar was 202,497 long tons, valued at $1,424,755, a decrease of 4% in quantity and 11% in value compared with 1926. The imports of crude feldspar decreased 2517 long tons, or 8%, and the value decreased $45,040, or 18%. The apparent consumption of crude feldspar in the U. S. in 1927 was 229,921 long tons; 88% of this total was domestic material. Probably all the feldspar consumed industrially, except that used for facing cement work, for covering prepared roofing, for "chicken grits," and like purposes, is prepared by fine grinding. In 1927, 30 operators running 32 mills in 13 states reported

223,915 short tons of ground feldspar, an increase of one each in the number of operators and mills, compared with 1926. The principal use of feldspar is as a flux in the pottery and enameling industries. It is also used as an abrasive in scouring soap, as a binder in the manufacture of abrasive wheels, as poultry grit, as a constituent of roofing material and in stucco or pebble dash, and also in artificial teeth. The industry by states is reviewed. R.A.H.

Production of potash on commercial basis. ANON. *Amer. Glass Rev.*, **48** [10], 20 (1928).—Ultimate independence of the U. S. from foreign producers of potash seems assured as a result of the progress made in potash explorations and reported by the Secretary of the Interior, Roy O. West, Dec. 3, 1928. E.P.R.

Origin of white clays and bauxite: chemical criteria of peneplanation. W. G. WOOLNAUGH. *Econ. Geol.*, **23** [8], 887–94 (1928). E.P.R.

Production of refractory rock in the U. S. in 1927. ANON. *Refract. Jour.*, **4** [38], 49 (1928). E.P.R.

Uses of silica. ANON. *Refract. Jour.*, **4** [38], 69 (1928).—Silica occurs in deposits of commercial importance in many different forms, such as vein quartz, in pegmatites, as sand, sandstone, quartzite, tripoli, and diatomite. A statistical report on the production of silica deals with silica of all kinds, silica sand or sandstone used in glassmaking, gravel and crushed material for building, for concrete and mortar for foundry and furnace work, and for cutting and grinding. E.P.R.

Microstructure of New Zealand lignites. I. W. P. EVANS. *New Zeal. Jour. Sci. Tech.*, **9**, 1 (1927).—At present there are two methods in general use for studying the microstructure of coal, the sectioning method and the more modern method of etching: (1) grinding a thin section with abrasives, (2) treating the coal with hydrofluoric acid and phenol until the coal is soft enough to be sectioned with a knife. The etching of a polished surface with sulphuric acid and chromic oxide is more rapid and brings out the fibrous structures better. **II.** *Ibid.*, **9**, 137 (1927).—After studying the microstructure of New Zealand lignites E. concludes that (1) the brighter parts of the Steventon lignite are formed chiefly from coniferous woods; (2) the attritus is also made up largely of these woods; (3) silica occurring as chalcedony and as unbanded colloidal masses accounts for much of the ash; (4) sulphur has been transferred from organic to inorganic compounds by the action of dolerite intrusions, and (5) the coal-forming material consists chiefly of transported débris and was laid down under water. **III.** *Ibid.*, **10**, 177 (1928).—The hard bright anthracite in the Brockly seams is found near igneous intrusions. Upon penetrating farther into the seam the coal deterioriates into ordinary lignite. These coal measures are associated with rhyolite conglomerates, grits, and sands in their upper part, and fire clays and shales in their lower part. The débris forming the coal was evidently not deposited *in situ*, since it is composed of fragments of forest trees and spores. The coal formation was evidently well advanced before the dolerite intrusion which folded the seams. C.R.A.

Revised statistics for clay products industry. ANON. *Can. Chem. Met.* **12** [12], 38 (1928).—The Dominion Bureau of Statistics has just issued revised figures for the productions of clay and clay products in Canada during 1927. An advance of 8% is recorded, sales amounting to $11,173,189, as compared with $10,357,323 in 1926. More than 50% of the total was produced in Ontario, and nearly 25% in Quebec. The capital employed in the 194 plants in operation was $30,437,607. As well as these plants, where clay and clay products were manufactured from domestic clays, there were 13 plants making clay products from imported clays, including porcelain insulators, ceramic floor tile, sanitary ware, fire brick, and other refractories. The total selling value of this latter group of factories was $2,088,238. Imports totaled $9,638,216. These included building brick and blocks; china, fire, pipe, and other clays, and zirconium silicate; drain tile, insulators,

earthenware, chinaware, fire brick, magnesite brick, silica brick, and other clay manufactures. Exports amounted to $282,712, under the following heads: building brick, $23,059; clay, unmanufactured, $2940; clay manufactures, $86,746; earthenware, $14,771; and porcelain insulators, $155,196. E.J.V.

Complete dissociation of silicates with carbonic and humic acids. R. GUILLIN. *Compt. rend.*, **187**, 673–75 (1928).—Humus soils were treated with diluted HCl and HNO_3. Soils low in lime gave a progressive but complete dissociation of the silicates, the lime being carried away with the solution while the Al_2O_3 combined with the humic acid. Fe_2O_3, however, was not fixed by the humic acid, the explanation being that free Fe_2O_3 or Fe_2O_3 liberated from combination as silicates is reduced in the humus medium to FeO and leached out if the water is permitted to flow away. This is the explanation for ferriferous springs. Al_2O_3 is liberated only by the decomposition and combustion of the humates. When thus liberated Al_2O_3 may combine with the associated SiO_2 giving rise to deposits of aluminum silicate (kaolin) or when combination does not take place, to beds of hydrated Al_2O_3 (bauxite). With humus soils high in CaO it was found that the higher the CaO content the more CaO is fixed by the humic acid and the less Al_2O_3. Silicates are apparently dissociated even in the presence of a great excess of CaO. The quantity of Fe_2O_3 present is greater than in siliceous soils, probably because Fe_2O_3 is deposited on calcareous nodules contained in the soil. Deposits of Fe_2O_3 may form by infiltration of iron-bearing water into calcareous beds from overlying humus beds. G. concludes that whether humus containing soils are calcareous or not, carbonic and humic acids are able to cause complete dissociation with elimination, first of K_2O and Na_2O, then of CaO and MgO, and finally of Al_2O_3 which alone is fixed by humic acid, the Fe_2O_3 being removed by reduction. H.I.

Structure of crystals of heulandite. PAUL GAUBERT. *Compt. rend.*, **187**, 829–31 (1928).—G. attributes the existence in heulandite of sectors with a pyramidal shape and with varying solubilities and varying optical properties to differences in chemical composition in different sectors. It is suggested that the pure heulandite (purely calciferous form) contains hydrated alumino-silicates of sodium, potassium, strontium, and barium in solid solution. H.I.

Schistose clays and clay schists. BERDEL. *Keram. Rund.*, **36**, 519–20 (1928).—Schistose (laminated) clays are rocks composed almost wholly of clay substance which do not slake or soften with water except after grinding or long contact. They have high fusion points and are very suitable for the manufacture of refractory grog. Clay schists are characterized by the presence of high amounts of impurities such as quartz, mica, hornblende, etc., and have lower fusion points than schistose clays. The conception that clay schists are produced by the intense metamorphism and partial dehydration of schistose clays is incorrect. To avoid misunderstanding of the general relations of schistose clays and clay schists, B. urges that the term clay schist or clay slate be discontinued and that such terms as mica-, quartz-, hornblende-schist, or phyllite be used, employing the name of the principal mineral composing the schist. H.I.

Potash and borax from Searles lake. J. E. TEEPLE. *Chem. and Ind.*, **47T**, 345–47 (1928).—The raw material having no cost, the percentage of recovery was unimportant. The aim was continuity of operation, not only in the sense of working 24 hours a day for 365 days a year, but in the sense of having no batch operations. T. found that standard commercial types of apparatus did not meet his aim, so he designed a considerable part of the plant, with success. H.H.S.

China clay production in England. H. WILLIAMS. *Chem. and Ind.*, **47**, 1324 (1928).—The 1927 production of Cornish china clay was 801,500 T. and china stone 63,612 T. The exports of clay and stone totalled 610,238 T. to foreign countries and 45,598 T. to British countries. The U. S. took 319,138 T. H.H.S.

Cadmium in Canada. ANON. *Chem. and Ind.*, **47**, 1375 (1928).—The new Cd plant of the Consolidated Mining & Smelting Co. at Trail, B. C., which began operation in Dec., 1927, is now producing ¾ T. daily. The widening use of the metal in countless lines of manufacture enables this amount, which is one-quarter of the world's previous supply, to be marketed without disturbance. H.H.S.

Kaolin or china clay in Canada. N. B. DAVIS. *Clay Prod. News*, **1** [9], 1 (1928).—Canada is glaciated over very large areas, hence there is little evidence of deep-seated weathering to be seen, but a deposit of kaolin occurs at Huberdeau, Quebec. Its composition is SiO_2 46.13, Al_2O_3 39.45, Fe_2O_3 0.72, loss on ignition 13.81%. At Kyuquot Sound, Vancouver Island, there is a deposit of pyrophyllite. No commercial production of kaolin or china clay was reported in 1925 and 1926. H.H.S.

Diatomite production in Canada. ANON. *Clay Prod. News*, **1** [9], 1–2 (1928).—Hitherto mined only in very small quantities in Nova Scotia (266 T. in 1927), diatomite promises to become a product of importance in Canada. Large deposits are under development at Digby Neck, N. S., and at Quesnel, B. C. Diatomite is used principally as a heat-insulator. The U. S. production for 1926 was 79,000 T. H.H.S.

Clay products production in Canada in 1927. DOMINION BUREAU OF STATISTICS. *Clay Prod. News*, **1** [9], 2 (1928).—The finally revised statistics just issued by Ottawa disclose an advance of 8% over 1926. The 1927 sales were $11,173,189, of which Ontario accounted for 52.4% and Quebec 24.5%. Capital employed in the 194 plants was $30,437,607; salaries $744,367 to 360 people, wages $4,024,940 to 4416 people. Fuel and electricity cost $2,088,724. Primary power employed totaled 551 units with a manufacturer's rating of 24,445 H.P. H.H.S.

Paragenetic classification of the minerals of Franklin, N. J. CHARLES PALACHE. *Amer. Mineral.*, **14** [1], 1–18 (1929).—The work is summarized as follows: A list is given of 137 species of minerals found in the region near Franklin, N. J. These may be classified genetically into 5 groups of varying importance. Of the whole number of species, 111 are found in the zinc ore-bodies and 98 in these only; 13 are found in granite pegmatites; 18 in iron ores of pegmatic origin; 26 in the Pre-Cambrian limestone; and 5 in the Paleozoic limestone. These five paragenetic groups are described, those of less importance first and then the main group of the zinc-ore minerals. A paragenetic table for this group shows 4 main subdivisions, *viz.;* (1) primary ores; (2) pegmatite contact minerals; (*a*) skarns and recrystallization products; (*b*) pneumatolytic products; (3) hydrothermal vein minerals; (4) surface oxidation products. Each of these groups is described with examples of characteristic mineral associations. The origin of the zinc ores is discussed. P.'s theory is that metasomatic deposits of hydrated oxides and silicates of iron, manganese and zinc were formed by replacement in the white limestone and that these ore-bodies were changed to their present mineral composition during the Pre-Cambrian regional metamorphism simultaneously with the recrystallization of the inclosing limestone. Subsequent intrusion of pegmatites produced recrystallization of the primary minerals near contacts, and formed skarns by interaction of ores and magmatic minerals. Pneumatolytic products of the pegmatite magma also reacted with the primary ores to produce numerous vein minerals and as the temperature fell hydrothermal veins of great variety were formed in the ore-body. These products of pegmatite intrusion are extremely diverse mineralogically but of minor importance compared to the great mass of the primary franklinite-willemite-calcite ores. F.P.H.

Doubly terminated quartz crystals occurring in gypsum. W. A. TARR. *Amer. Mineral.*, **14** [1], 19–25 (1929).—Quartz crystals, showing the development of the plus and minus rhombohedrons on both ends of the prism, occur replacing massive gypsum at a locality near Acme, N. Mex. The sequence in the development of the various faces

on the crystals is readily traced. Silica-bearing solutions entered the gypsum and replaced it by quartz crystals, which are colored by residual hematite from the gypsum. F.P.H.

Fluorescence of minerals in ultra-violet rays. L. J. SPENCER. *Amer. Mineral.*, **14** [1], 33–38 (1929).—Certain crystals of fluorspar (fluor or fluorite), especially the twinned cubes from the lead mines of Weardale in County Durham, England, display different colors when viewed from different points of view. The color as seen varies according to the relative positions of the source of light, the specimen, and the eye of the observer. F.P.H.

Feldspar in 1928. ANON. *Rock Prod.*, **31** [26], 144 (1928).—The feldspar industry needs a parent organization or national association to handle the problems that press the producers. A standardization of grades, the need of a protective tariff, closer cooperation among grinders and producers, and development of new uses for feldspar are some of the problems that could and should be handled by a national association. The necessity for an organization of this kind is felt by the producers and in reply to the question as to what was the greatest problem in the feldspar industry as a whole, 60% of the replies expressed the need of a national association of some sort. Judging from the reports received from producers, the tonnage of feldspar produced during 1928 will be very close to that of 1927, which was considered a good year from that standpoint. The selling price apparently was the same as for 1927. The indications are that the producing capacities for 1929 will be 20% larger than for 1928, as one larger producer expects to build a new plant in N. C. and several are planning additional plant and quarry equipment. Competition from foreign sources did not increase according to reports. F.P.H.

Silica sand industry shows activity in 1928. ANON. *Rock Prod.*, **31** [26], 145–46 (1928).—No particularly new developments in the silica sand industry are noted during 1928. In the east, operators are satisfied with the use of the chaser mills and screw washers, finding them the most economical and best for production so that generally the changes have been in other equipment. Increased size in washers is becoming common, and where formerly 20-in. and 22-in. washers were ordered, the producers are now installing 30-in. ones. Similarly, larger crushing units are becoming popular. Another development is the tendency toward elimination of hand labor through the use of more up-to-date methods of handling drained sand, and the installation of steam or electric shovels in the quarries and pits. F.P.H.

Pumice. ANON. *Rock Prod.*, **32** [1], 49 (1929).—The consumption and value of pumice for 1928 will probably show a slight increase, some of which can be traced to its increasing use as a sound insulator and as an aggregate for light weight concrete slabs for building purposes, especially fireproof roof slabs. F.P.H.

BOOK

Geology. A. P. BRIGHAM. Reviewed in *Econ. Geol.*, 23 [8], 930 (1928); see also *Ceram. Abs.*, **8** [2], 146 (1929). E.P.R.

Chemistry and Physics

Reaction between magnetite and ferrous sulphide. F. S. WARTMAN AND G. L. OLDRIGHT. Bur. Mines, *Rept. of Invest.*, Serial No. 2901 (Nov., 1928).—Magnetite and ferrous sulphide will be found in stable association in roaster calcines because the temperatures found in roasters are below those at which magnetite and ferrous sulphide react to an appreciable extent. The over-all result of the reduction of magnetite by ferrous sulphide in the temperature range 1000 to 1300°C may be represented by 3 equations. (1) $FeS + 3Fe_3O_4 = SO_2 + 10FeO$; (2) $FeS + Fe_3O_4 = S + 4FeO$; (3) $FeS + 4Fe_3O_4 = SO_3 + 13FeO$. With the mixtures tried in this study the most of the

reduction proceeded according to the first reaction. Increasing the proportion of sulphide increases the rate and also to some extent the importance of the other reactions. Increase of temperature markedly increased the rate of reduction. Increase of partial pressure over the melt, of the gases formed by the reaction, greatly decreased the rate of reduction. R.A.H.

Dehydrated gibbsite. JACQUES DE LAPPARENT AND ERNEST STEMPFEL. *Compt. rend.*, **187,** 305–306 (1928).—Bauxite, $Al(OH)_3$, when heated begins to lose water at from 200 to 250°C and at 270° has lost nearly all its combined water although it continues to lose small amounts up to 500°. Optical studies of unheated bauxite and bauxite heated to various temperatures show that the unheated bauxite occurs in monoclinic plates of hexagonal outline with easy cleavage parallel to (001) and twinning after (001) and (110). Extinction is inclined, the optic axial plane is perpendicular to (001) and the acute bisectrix, γ, makes an angle of 26° with the normal to the cleavage. After heating to 250° in a vacuum and cooled the crystals are filled with bubbles but the optical properties remain like those of the original bauxite. After heating to 300° the crystals have become orthorhombic, the extinction is no longer inclined but parallel and the bisectrix, γ, lies in the plane 001. The birefringence is lowered to 0.011 as compared with 0.019 in the original bauxite. Crystals heated to 600° are clear and transparent and contain no bubbles. The optical properties are like those of the crystals heated to 300° except for a lower birefringence. These optical properties remain unchanged up to 1000°. The retention of a little water up to 500° is attributed to the porous structure of the crystals between 250° and 500°. H.I.

Suspensions of kaolin. R. DUBRISAY AND ASTIER. *Compt. rend.*, **187,** 978–80 (1928).—Kaolin was washed with water and purified by sedimentation; 5 g. of the purified clay in 150 cc. of H_2O was mechanically agitated for 24 hrs., the suspension thus obtained allowed to stand for 1 hr., and then decanted; 20 cc. of the decanted liquid was put in a graduated cylinder and 20 cc. of a reagent, acid or base, was added. The rate of settling (in mm./24 hrs.) of the resulting mixture was plotted against p_H. The curve with a minimum at about p_H 11.9 is evidence that the protective effect of bases and acids is related to their degree of ionization although this is not the only factor for it is known that alkaline earths flocculate suspensions even at very great dilutions and, on the other hand, buffer solutions of phosphate act quite differently than liquids having the same p_H value. The results by sedimentation were confirmed by nephelometric measurements. The results show a maximum of opacity corresponding to a maximum of stability. H.I.

Effects of heat and loss of water on optical properties of heulandite. PAUL GAUBERT. *Compt. rend.*, **187,** 1057–59 (1928).—Cleavage flakes of heulandite were heated in an inert liquid medium on the stage of a microscope. Since no loss of water occurred below 109°, changes in optical properties occurring below that temperature were ascribed to the effects of heat alone. The birefringence increased progressively with increase in temperature up to about 109°. The increase in birefringence was not the same for all sectors. The plane of the optic axis was rotated when the section was heated. That the plane of the optic axis did not return to its original position and that the birefringence did not return to its original value on cooling were ascribed to the presence of optical anomalies. With the loss of about $^1/_2$ molecule of H_2O the crystal became almost uniaxial. With the loss of a greater amount than this the plane of the optic axis was turned 90° from the original position. H.I.

Action of sulphurous gas at high temperatures on basic rocks and glasses and probable origin of thermal sulphated waters. ALBERT POITEVIN. *Compt. rend.*, **187,** 1148–50 (1928).—Basic rocks and basaltic glasses heated to 900° in a furnace using a coke gas were covered after cooling with efflorescent salts which analysis showed were

composed wholly of sulphates of Na, K, Mg, and Ca, sodium sulphate composing more than 80%. P. suggests that during volcanic activity in the fumerolic period sulphurous gases attack basic rocks and basaltic glasses producing soluble sulphates which are dissolved in the thermal waters of following periods and give rise to thermal sulphur springs. H.I.

The ultra-violet, visible, and infra-red reflectivities of snow, sand, etc. E. O. HULBERT. *Jour. Opt. Soc. Amer.*, **17**, 23–25 (1928).—The diffuse reflectivities in the region 0.3 to 7.0 were measured for snow, sand, crushed quartz, plaster of Paris, white cotton cloth, and sodium carbonate. The ultra-violet reflectivity of snow was relatively high, being 2 to 4 times that of sand. This gives a physical basis for the current idea that ultra-violet glare may be an important factor in snow blindness. H.I.

"Acid-alkalimeter," a direct-reading p_H meter. KENNETH H. GOODE. *Jour. Opt. Soc. Amer.*, **17**, 59–71 (1928).—Two improved types of instruments for electrometric determination are described, each using two 3-element vacuum tubes with oxide coated filaments. The indicating device is a special Weston 3-terminal voltmeter-milliammeter. One instrument is a D.C. model using batteries, the other an A.C. model for p_H determinations over long periods using the 110-volt lighting circuit. Detailed hook-ups are described. The instruments were designed to include the whole p_H scale from 0 to 14 and p_H values may be read with an accuracy of 0.1 unit. For greater accuracy modifications may be made to give a full scale reading of 4.0 p_H units with an accuracy of about 0.04 p_H units. H.I.

Change of the hydrogen-ion concentration of stable kaolin suspensions because of mechanical movement in capillary tubes. ALICE JEPPESEN. *Kolloid Zeit.*, **45**, 156–58 (1928).—The following preparations of standard Zettlitz kaolin were made up for viscosity measurements: (*a*) 12 g. kaolin and 2 cc. 1/10 *N* NaOH and 46 cc. H_2O; (*b*) 12 g. kaolin and 3 cc. 1/10 *N* NaOH and 45 cc. H_2O; (*c*) 12 g. kaolin and 4 cc. 1/10 *N* NaOH and 44 cc. H_2O. After standing $2^1/_2$ months the viscosities were measured by the capillary tube method. The first measurements gave almost the same viscosity values for *a*, *b*, and *c*. After standing for 4 months there was a large increase in viscosity in *a* and *b* and a small increase in *c*, and *a* and *b* had coagulated while *c* had not. In order to determine whether viscosity changes were due to standing or to repetition of the experiment on the same material a large sample of *c* was made up and divided into 2 parts. One part (I) was shaken but not put through the capillary tube while the other part (II) was shaken and put through the tube. The p_H of I decreased gradually and uniformly from 10.90 at 6 days to 10.77 at 11 days while II decreased rapidly from 10.45 at 6 days to 9.67 at 11 days. After 33 days part I was again divided into 2 parts and the same procedure was repeated. Here also the part put through the viscosity apparatus showed a rapid decrease in p_H while the other part showed a uniform and slow decrease. H.I.

Hardness testing. H. M. GERMAN. *Trans. Amer. Soc. Steel Treating*, **14** [3], 343–54 (1928).—New ideas pertaining to Brinell, Rockwell, and scleroscope hardness testing are presented. Charts showing comparative hardness values of Brinell with Rockwell C, Rockwell B, and scleroscope, and a brief description of the Vickers and monotron hardness testing machines are given. E.P.R.

Titanium nitride and oxychlorides. E. A. RUDGE AND F. ARNALL. *Chem. and Ind.*, **47T**, 376–80 (1928).—The copper-colored crystalline compound of Ti produced during the blast-furnace process for the manufacture of iron (which Wöhler in 1850 thought to be the cyanonitride $Ti(CN_2{\cdot}3Ti_2N_2)$ is shown to be the nitride TiN mixed with graphite. The crystalline compound obtained by the action of Cl on this substance (which Wöhler thought to be the cyanochloride $2TiCl_4CNCl$) is shown to be the oxychloride $3TiCl_4$, TiO_2. There are several other oxychlorides of Ti. H.H.S.

Coal in the chemical industry. H. T. ROSE. *Chem. and Ind.*, **47**, 1301–1304 (1928).—Receiving the Grasselli Medal, R. said that coal had been discovered three times: (1) as a raw fuel for heat and power, (2) as a source of coke and gas, (3) as a chemical raw material. The last-named aspect was developed by R. in his acceptance speech. The chemical age of coal has arrived. H.H.S.

Formation of tridymite from quartzite. PETER P. BUDNIKOFF. *Feuerfest*, **4** [9], 136–38 (1928).—The function of lime which is added to silica brick is to form a bond and to hasten the formation of tridymite by the solution of quartz. The present investigation is a study of the effect of a phosphate on the rate of formation of tridymite from Ukrainian quartzite. The composition of the bonding agent is given as follows: SiO_2 42.82, CaO 27.60, $Al_2O_3 + Fe_2O_3$ 5.98, P_2O_5 15.60, $CO_2 + F_2$ 6.20, SO_2 2.24. One per cent of this bonding agent + 2% CaO was added to the quartzite that was investigated. The silica brick with this bond was compared with one containing lime alone. The phosphate bond greatly accelerated the formation of tridymite and is being investigated on a plant scale in the Ukraine. Data on the volume changes of the two bands of silica brick after one and three firings are given. Photomicrographs of the two brands are shown. F.P.H.

The equilibrium diagram. W. ROSENBAIN. *Engineer*, **145**, 260–62 (1928).—Equilibrium in the fields of metallurgy and chemistry is discussed and summarized. L.A.P.

The "salt error" of indicators in colorimetric determination of p_H. I. M. KOLTHOFF. *Jour. Phys. Chem.*, **32** [12], 1820–33 (1928).—K. attempts to calculate salt correction of indicators on basis of the Debye-Hückel equation. If the ionic strength of the solution is much larger than that in the ordinary buffers, calculated corrections are higher than experimental values. Again, indicators of the same type vary in behavior. Average salt correction is given for the various phthaleins at ionic strengths 0.0025 to 0.1. These values are related to an ionic strength of the buffer solution of 0.1. In reporting salt error of indicators, ionic strength and composition of buffer mixture must be mentioned. The salt correction depends also upon the properties of the buffer solution. Methyl-orange and methyl-red show very small salt errors under different conditions and so are very suitable indicators. Their hybrid character explains this behavior. Indicators having hybrid properties are ideal for p_H measurements. L.A.P.

Production of color in glass and gems by X-rays and radium rays. M. C. REINHARD AND B. F. SCHREINER. *Jour. Phys. Chem.*, **32** [12], 1886–87 (1928).—The following gems are unaffected by very intense X-radiation and by β and γ rays from radon: topaz, aquamarine, amethyst, garnet, white diamond, and brown diamond. The white diamond fluoresced in a beautiful blue color when exposed to a radon tube; none of the other gems fluoresced. Natural quartz is unchanged, while fused quartz is colored in an irregular brown pattern by X-rays. L.A.P.

Comparative interpretation of theory of fine structure of H-atom spectrum lines. STJEPAN MOHOROVICIC. *Arhiv za Hemiju i Farmaciju*, **2** [1], 6–14 (1928). E.J.V.

Use of the Endell heating microscope for testing solid fuels. E. BERL AND H. SCHILDWÄCHTER. *Brennstoff-Chem.*, **9**, 159–60 (1928).—The apparatus consists of a small electric tube furnace, the tube of which is illuminated by a small arc light, and a microscope of 45 diameters magnification. By use of an inert atmosphere (H_2, N_2, or CO_2) in the tube the destructive distillation of a coal sample can be observed. Temperatures of initial decomposition, tar evolution, coke formation, and end of gas formation are observed. (*C.A.*)

Some new curves for the determination of feldspars by the method of Fedorov. HENRI SIGG AND GEORGES FAVRE. *Bull. Soc. Vaud. Sci. Nat.*, **51**, 341–80 (1917); *Mineralog. Abs.*, **3**, 515.—From a revision of existing data on plagioclase twins the

authors infer that the pericline law is not the only one in which the plane of association varies with the chemical composition of the feldspar. This has been adversely criticized by Sabot (cf. following abstract.) (*C.A.*)

The Fedorov method and its application to the determination of feldspars. R. SABOT. *Compt. rend. soc. phys. hist. nat. Genève*, **35**, 72–76 (1918); *Mineralog. Abs.*, **3**, 515.—The influence of a triclinic $KAlSi_3O_8$ on the optical constants of the plagioclases was studied. The variation of the twin plane in Carlsbad and Esterel-Ala twins was determined. Fine twin-lamellae parallel to $(1\bar{1}0)$ and (110) were observed. In normal hemitropes no variation is found in the position of the twin plane. The explanation of these variations as due to vicinal faces (Sigg and Favre) is not accepted. (*C.A.*)

Proposals for unified tests of ceramic materials. O. KALLAUNER. *Intern. Congress Testing Materials*, **II**, 338–58 (1927).—Proposals made were: (*a*) A rapid determination of the harmful effect of lime nodules in fired brickware: five specimens are placed in a covered vessel on a support above water which is brought to boiling in 1 hr., and allowed to boil another hour. After 4 hrs. the specimens should be free from defects due to lime nodules. (*b*) Testing roof tile for impermeability to rain: a pair of 3-course tile is surrounded by sheet iron cemented with litharge and glycerol, and water falls under specified conditions; the tile should remain dry on the under side for 24 hrs. (*c*) An exclusively volumetric determination of the absorption of ceramic specimens: determination on a volume instead of on a weight basis, the absorption is expressed more significantly. (*d*) The determination of soluble salts in ceramic clays: the methods of the Tonindustrie Lab. in Berlin are recommended. (*e*) The determination of soluble salts in ceramic products should be carried out by similar methods. (*f*) Testing the acid resistance of ceramic products by treating 1 g. with $1.84 H_2SO_4$, boiling 30 min., cooling, diluting, adding NaOH, and weighing the residue, after drying at 120°. Tests for roof tile should include permeability, absorption, frost resistance, flexure, and impact resistance. (*C.A.*)

Measuring with approximation the absolute size of pores. M. A. RABINOVICH AND N. S. FORTUNATOV. *Jour. Chem. Ind.* (Moscow), **5**, 689–94 (1928).—The porosity of technical materials is usually characterized as relative volume of pores; *viz.*, the ratio of the total volume of the pores to the total volume of the body. The relative volume of pores reveals nothing about the real size of the pores. Yet, for the technological characterization of materials, the knowledge of the absolute size of pores would be valuable. *E.g.*, if the porous substance is a carrier (bearer) of great surfaces, it is by no means indifferent what the absolute size of pores is; the "specific surface" of the substance is the greater the smaller the pores, the porosity remaining constant. Again, the mechanical strength of the materials certainly depends on the ratio between the average size of the pores and their number in a unit of volume. Finally, the absolute size of pores undoubtedly has an interest in the characterization of diaphragms in electrochemical processes and in many other cases. Considering the structure of porous bodies as a system of communicating capillary cylinders, R. and F. proceeded to determine the average radii of the pores for various parts of volume porosity; their method was based on the investigations of Zsigmondy, Anderson, and W. Bachmann who calculated the dimensions of capillary pores of gels from the data obtained by determining vapor pressures in the processes of hydration and dehydration of gels. Minkovskii's equation was modified thus: $r = K/(\log P_0 - \log P_1)$, where K is a constant, P_0 vapor pressure over the flat surface, and P_1 vapor pressure over the meniscus in the capillary pore, and it was assumed that $P_0 - P_1$ is not less than 0.05 mm. The radius to be measured is the greater the greater the constant K, which, in turn, increases with the decrease of temperature, the values of K were determined for 3 different temperatures. The apparatus used by

R. and F. is described in detail and a drawing of it is given. Tables are given which contain all the data obtained in the determinations of Ural pine charcoal, Ural birch charcoal, activated charcoal, an American graphite electrode, a German graphite electrode, kaolin ignited at 900°, hard porcelain ignited at 1410°. In the order of decreasing relative volume of pores the charcoals ranged themselves thus: birch charcoal, pine charcoal, activated charcoal; yet the porosity determinations show that activated charcoal is really the most porous of the 3, birch charcoal second, and pine charcoal third. Parallels were also drawn between the 2 graphites and between the kaolin and the porcelain. In connection with the above experiments attention is drawn to the following analogy. Von Bemmeln and Bachmann have shown that the greater the age, and consequently the surface, of a gel, the less the vapor pressure beginning with which the irreversible processes of hydration and dehydration take place (hysteresis). For old gels the range of hysteresis begins with high values for vapor pressure, the water content being low; the range of hysteresis is in that case very small, and sometimes practically nil. These experiments with determinations of vapor pressures show that, for ignited porcelain, the hysteresis begins higher than for kaolin, and the range of the second is far greater than that of the former. The process of ignition at high temperature evidently leads to the same changes in the structure of the porous material as those which were observed in the process of aging of gels. (*C.A.*)

The relation between coagulation, electrokinetic migration velocity, ionic hydration, and chemical influences. An experimental study of clay, quartz, and permutite suspensions. PAULI TUORILA. *Kolloidchem. Beihefte*, **27**, 44–188 (1928).—The velocity of electroëndosmosis of water against glass surfaces was lowered by electrolytes according to the following series of cations: $LiCl < NaCl < KCl = KNO_3 < AgNO_3 = CsCl < HNO_3 < HCl$. The velocity of cataphoresis of the particles of a paraffin sol was lowered by the same electrolytes in the same order except that $CsCl < AgNO_3$ and in the case of clay particles, $AgNO_3 > CsCl$. In all concentrations the order of Li, Na, K, Cs, and H remained the same, but the migration velocity-concentration curve for $AgNO_3$ cut the curves for KCl and CsCl. The velocity of coagulation of these suspensions was speeded up by these electrolytes in the same order as the cataphoresis velocity was decreased except that the place of H in the series was dependent on the concentration of electrolyte used. The relation between migration velocity and time of coagulation could be expressed by an equation. With bivalent cations, the migration velocity of these suspensions was decreased in the order $MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$ and the decrease in the time required for coagulation followed the same order. Results are also presented for the effect of salts with acids and with bases, the velocity of coagulation still being related to migration velocity. The coagulation of mixtures of sols having particles of the same and opposite charge was also investigated. (*C.A.*)

Observations on magnetite, ilmenite, hematite, and their relation to the system FeO–Fe_2O_3–TiO_2. PAUL RAMDOHR. *Neues Jahrb. Min. Abt. A, Beil.-Bd.*, **54**, 320–79 (1926).—From a microscopic and chemical study of natural minerals some data were accumulated on the systems Fe_2O_3–Fe_3O_4, Fe_3O_4–$FeTiO_3$, $FeTiO_3$–Fe_2O_3, $FeTiO_3$–TiO_2, Fe_2O_3–TiO_2, and Fe_3O_4–TiO_2. Analyses of ilmenite are included. (*C.A.*)

The dehydration of kaolin. H. A. J. PIETERS. *Thesis*, **1928**, 148 pp.—A review with 334 references is given of the literature on kaolin, its constitution, dehydration, rehydration, etc. P.'s work consists of dehydration and rehydration experiments, including static determination of the solution pressure of kaolin, the action of HCl and Na_2CO_3 on kaolin and related substances and attempts to synthesize kaolin. The material used was mainly Zettlitz kaolin; other samples analyzed were from Passau and from N. C. For the analysis the KOH method after ignition was found best; HCl decomposes incompletely. Only up to 15.9% of the total alumina dissolves in 2 *N* HCl

during 6 hrs. on a water-bath; nothing in $2N$ Na_2CO_3 solution. The density was 2.64; after ignition at 700° 2.47; at 1100° 2.67. Kaolin, $Al(OH)_3$ and SiO_2 were found to be hydroscopic; ignited kaolin (metakaolin) was slightly hygroscopic and ignited $Al(OH)_3$ was considerably more so. For the thermal analysis the kaolin was heated in an electric furnace (10° per min.). Three heat effects were observed: at 100° by moisture escape, at 600° by dehydration, at 950° by exothermic decomposition. Kaolin was progressively dehydrated in a nichrome furnace. Air saturated with water vapor at different temperatures was passed over the substance and the temperature determined for each H_2O pressure at which the kaolin lost weight. From the practically vertical center parts of the dissociation isobars, (S curves) on which t is largely independent of x, the following values for a p-t curve (dynamical method) were found: p = 17 mm. at 430°, 149 mm. at 475°, 355 mm. at 505°, 760 mm. at 540°. Passau and N. C. kaolin gave identical results; at 540° the dehydration is complete. At 17 mm. H_2O pressure 0.7% water was lost at 420° (4 hrs.), 11.6% at 470° (3 hrs.) (90% of total); below 400° 0.4 to 0.6% water escapes. From the data on the quasi monovariable equilibrium a heat effect of dehydration of 300 cals. per g. kaolin was calculated. Further experiments were made to find the limit of dehydration at p_{H_2O} constant (17.5, 149 and 760 mm.) for different temperatures, also at 3.6 atmospheric pressure. Dehydration of more than 13% was obtained for p_{H_2O} = 0 at 470° for p_{H_2O} = 17 mm. at 490°, for p_{H_2O} = 149 mm. at 510°, for p_{H_2O} = 760 mm. at 580°, for p_{H_2O} = 3.6 atm. at 640°. Dehydration of pholerite is considerably slower: the corresponding values are 510°, 510° and 560° for the first three p_{H_2O}. The grain size (0.5 to 2μ) is not believed to be of great influence. The dehydration follows in general the rules for a solid solution of water content x. Between about 3 and 13% water the equilibrium is apparently univariant. Metakaolin (dehydrated kaolin) does not absorb any water at suitable temperatures below 700° for p = 149 at 760 mm.; little water was taken up after previous evacuation of the substance. In a nickel-steel autoclave Al_2O_3 ignited at 950° takes up 16 to 17% H_2O, forming a monohydrate at water pressures of 125 and 150 atmospheres (temperature about 300°); ignition of the oxide above 1100° destroys this absorptive ability. Amorphous SiO_2 (from water glass) takes up 2.7 to 45.7% H_2O at 80 to 130°. Ignited Zettlitz kaolin absorbs up to 14.7% water at pressures of 50 to 130 atmospheres (2 to 3 days) depending on the previous ignition temperature. Up to 550° ignition temperature 14.5%, for 600 to 850° 13.0%, for 900° 12.5%, for 1000° 11.0%, for 1050° 3.0% and 1.6 down to 1.0% for 1100 to 1500° (2 days rehydration, p_{H_2O} between 80 and 120 atmospheres.) A mixture of Al_2O_3 + $2SiO_2$ takes up only 10.5% water at 100 atmospheres, 2 days; metakaolin under the same circumstances takes up 12 to 13%. Sillimanite takes up 0.7 to 1.3% H_2O at 85 atm., 2 days, nothing after ignition at 1000°. It seems likely that ignition of kaolin over 1100° gives sillimanite + crystalline SiO_2. Static determinations of the solution pressure of kaolin and pholerite were made in an electric furnace with a Hg manometer, the tube being evacuated at constant volume. The water yielded was weighed in a $CaCl_2$ tube, after initial evacuation at 400°. For a H_2O loss of 3.4 to 11.5% the p-t curve so determined agreed well with the dynamic values. The pholerite curve although more retarded by slow decomposition also agrees with the dynamic one and with that of kaolin. Action of Na_2CO_3 on metakaolin indicates that it contains neither free SiO_2 nor Al_2O_3; ignition above 900° only gives a slight soda solubility. The Al_2O_3 from metakaolin dissolves almost completely in HCl if the ignition temperature is below 900°; from there on it is very small (Al_2O_3 solubility itself decreases more slowly). Hydrated metakaolin is insoluble in HCl, and has a dehydration characteristic like kaolin, yielding its water a little more readily. It is concluded that metakaolin (product between 600° and 900°) is most likely a kaolin anhydride, $Al_2O_3 \cdot 2SiO_2$. Attempts to synthesize kaolin failed. (*C.A.*)

Eutectic freezing point lowering in binary mixtures. V. The determination of molecular weight from the position of the eutectic. E. KORDES. *Z. anorg. allgem. Chem.*, **173**, 1–13 (1928).—When binary systems contain saturated mixed crystals in the solid phases or incomplete miscibility in the liquid phase, departures from the general equation for eutectic freezing point lowering result which are qualitatively the same as for the freezing point lowering in dilute solution that is, the freezing point is higher than the equation indicates. Quantitative relations between the magnitude of the departures from the eutectic freezing point lowering for "normal" binary systems and the composition of the mixed crystals or the gap in miscibility have not been discovered. The general eutectic equation provides a method for determining molecular weights which has the advantages over methods based upon the laws of Raoul and of van't Hoff that it is not limited to dilute solutions and is just as applicable to electrolytes as to nonelectrolytes. (*C.A.*)

BOOKS

Ullman's Encyclopædia of Technical Chemistry. Vol. I. 2nd ed. (Abasin to Ausdehnung) Pp. viii + 808. Urban & Schwarzenburg, Berlin, 1928. Price 48 RM.—The first volume of the second edition (in 10 vols.) has been called for only three years after the last volume of the successful first edition. The work is complementary to Thorpe's well-known Dictionary in that Ullman is more concerned with chemical technology and Thorpe with applied chemistry. Reviewed in *Chem. and Ind.*, **47**, 1323–24 (1928). H.H.S.

Chemical Publications; Nature and Use. MELVIN GUY MELLON. McGraw-Hill Book Co., N. Y., 253 pp. Price $6.50. Reviewed in *Min. and Met.*, **10** [265], 47 (1929).—This textbook is intended for a college course in chemical literature, planned to give the student an idea of the types of chemical information available in print, the way to find them, and how to use them. The information given is ample to equip the user for satisfactory searching of the literature. F.P.H.

Colloid Symposium Monograph. Vol. 6. Edited by Harry Boyer Weiser, Chemical Catalogue Co., N. Y., 1928. 346 pp. $6.50. Reviewed in *Min. and Met.*, **10** [265], 47 (1929).—Contains twenty-five papers by American and English specialists, dealing with a wide variety of subjects. The volume, with its predecessors, brings together advances in this field. F.P.H.

Visual Lines for Spectrum Analysis. D. M. SMITH. Adam Hilger, London. 34 pp. 5*s*. Reviewed in *Min. and Met.*, **10** [265], 48 (1929).—The publisher of this booklet manufactures a wave-length spectrometer which enables metals present in various substances, as constituents or impurities, to be identified rapidly and easily. The present publication gives the necessary tables of wave-lengths, describes the technique of the processes, and shows various applications of the method in chemical and metallurgical analysis. F.P.H.

PATENTS

Method of obtaining titanic oxide. LOUIS E. BARTON AND CHARLES J. KINZIE. U. S. 1,695,270, Dec. 18, 1928. In obtaining titanic oxide from titaniferous ores, the step which consists in mixing and heating the ores together with sulphuric acid and an alkali metal sulphate to formation of water soluble salts, but without fusion.

Method of mining boron compounds. HENRY BLUMENBERG, JR. U. S. 1,696,075, Dec. 18, 1928. A process of mining deposits of boron compounds containing kernite, comprising subjecting the deposit to an alkaline solution of a compound of an alkali metal to convert the kernite to an easily soluble metaborate and causing the metaborate to go into solution, and removing the solution from the deposit.

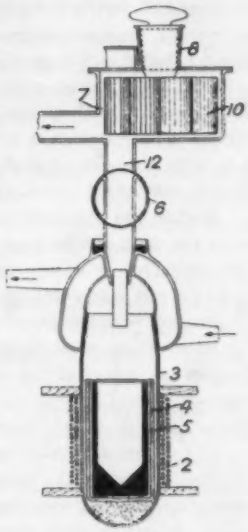
Method of producing big crystals. PAUL SEIDLER. U. S. 1,697,543, Jan. 1, 1929. The method of producing big crystals, which consists in adding vegetable substances to

salt solutions, concentrating the salt solutions by evaporating at raised temperature, allowing the salt solutions to cool slowly, removing the formed crystals from the mother liquor and centrifugating and drying such crystals.

Process for recovering barium as barium carbonate from barium silicates. CAMILLE DEGUIDE. U. S. 1,697,722, Jan. 1, 1929. A process for recovering barium as barium carbonate from barium silicates containing silica, consisting in grinding the same with water, subjecting the mixture to the action of carbonic acid, and separating from the barium carbonate the gelatinous silica thus set free.

Process for producing aluminum chloride. CLAUDE G. MINER. U. S. 1,698,238, Jan. 8, 1929. The process of producing aluminum chloride from aluminous material which comprises reacting upon the aluminous material, in the presence of carbon, at about 1500°C, with hydrochloric acid.

Determining gas content of solids. C. LORENZ AKT.-GES. Brit. 299,303, Dec. 19, 1928. In determining gas content of solid bodies by heating them *in vacuo*, the furnace is evacuated before the introduction of the sample, and the latter operation is effected without spoiling the vacuum. The crucible in which the sample is to be heated is preferably previously heated to a higher temperature in the furnace so as to remove all gas absorbed on it. In the illustrated apparatus the furnace consists of a quartz tube 3 heated by a high frequency coil 2 and containing a magnesia crucible 4 within which is a graphite crucible 5. A vertical shaft 12 in which is a stop-cock 6 communicates with the lock chamber 7, which is in communication with the air pump, preferably a high vacuum diffusion pump. The lock chamber contains a rotating drum provided with cylindrical chambers 10 which are charged with the test material through the opening 8, and on rotation of the drum discharge it down the shaft 12 into the furnace. In operation, the lock chamber and furnace are first evacuated, while the latter is heated to de-gas the crucible; the cock 6 is then closed, the samples fed into the chambers 10, the lock chamber is again evacuated, and finally the samples are fed into the furnace.



Alkali silicates. I. G. FARBENINDUSTRIE AKT-GES. Brit. 299,763, Dec. 28, 1928. In the production of water-glass solutions by heating under pressure siliceous raw materials and alkali lyes, the latter comprise liquors containing alkali chloride obtained by electrolysis of sodium or potassium chloride solutions. In examples, finely ground sand is treated (*a*) with a liquor containing 120 g. NaOH and 120 g. NaCl per liter at 240°C under a pressure of 30 atmospheres, and (*b*) with a liquor containing 70 g. NaOH and 210 g. NaCl per liter at 200°C under a pressure of 15 atmospheres.

General

Ceramic tour abroad. W. C. KEMPF. *Ceram. Age*, **12** [1], 27–28 (1928). A.E.R.W.

Performance standards in industry. J. A. PIACITELLI. *Ceram. Age*, **12** [2], 61–66 (1928); reprinted from *The Annals* of the Amer. Acad. of Political and Social Science. A.E.R.W.

American Ceramic Society Meeting at Chicago. ANON. *Ceram. Ind.*, **12** [1] 40–41

(1929).—Partial list of papers presented at the Annual Meeting of AMERICAN CERAMIC SOCIETY is given. F.P.H

Ceramic Ware of U. S. ANON. *Amer. Glass Rev.*, **48** [6], 20 (1928); *Brick Clay Rec.*, **73** [13], 882–83 (1928).—A discussion of the American Ceramic Exposition and conventions of associations allied to the industry that was held in Chicago the week of February 4, urging all ceramists to coöperate to the greatest extent and sell their industry to the country. E.J.V.

American Face Brick Association convention. ANON. *Brick Clay Rec.*, **73** [13], 884–88 (1928).—A report of the seventeenth annual convention held at Hot Springs, Va., Dec. 5 to 7, 1928. Forty-nine new companies have been added to the membership with a combined production of 535,000,000 bricks. It was definitely established that a brick house costs only $200 to $400 more than a frame house. Active field engineers are needed to dispel the false idea of high price and educate the public to the advantages of brick construction. Greater progress has been made in trade relations between dealer and manufacturer. Contract forms have been sent out to 2500 face brick manufacturers, dealers, and distributors for suggestions. E.J.V.

Selling products in modern markets. E. M. WEST. *Brick Clay Rec.*, **73** [13], 890–92 (1928).—A masterly analysis of the task confronting the manufacturer of today after his goods are manufactured, with specific suggestions for the sale of clay products. W. discusses synchronization of manufacturing and a distribution census taken in 11 cities. The question is asked, "Is it impracticable for a face brick manufacturer to join with a roofing or wall paint manufacturer in an effort to create the type of dealer who is competent to sell the products that are offered for sale?" E.J.V.

Hollow tile industry. ANON. *Brick Clay Rec.*, **74** [1], 37–38 (1929).—Beginning with the first of the year the Hollow Building Tile Assn. dropped its old name and will hereafter be known as the Structural Clay Tile Assn. A new advertising program is to be put into force and quite a few new recommendations have been adopted in connection with the plan to get more business. E.J.V.

Face brick manufacturers and dealers. ANON. *Clay-Worker*, **90** [6], 450–55 (1928).—A report of the seventeenth annual convention held at Hot Springs, Va., December 5 to 7, 1928. "Wet Walls and Efflorescence," "Facing Business Changes Squarely," by E. M. West, "Getting Face Brick's Share of the Small House Field," by J. J. Stein, and other addresses were heard. E.J.V.

Boiler firing. H. PENNINGTON. *Pottery Gaz.*, **54** [619], 83–85 (1929).—A sketch was given of the various patents which have been taken out since the investigations of James Watts in 1785, undertaken with a view to obtaining more efficient combustion in boiler firing. It was explained that Watts' idea was to push the fuel on to the front of the furnace so that it coked into a mass and was then propelled along at intervals, thus causing the volatile gases from the incoming fuel to travel over a bed of incandescent carbon. This paved the way for other inventions, leading up to the traveling chain grate stoker invented by John Jukes in 1841. The chain grate stoker of today might be regarded as being an improvement upon Jukes' grate; the basic idea has hardly been modified. The objects in the use of mechanical stokers and the methods of obtaining them are described in detail. E.J.V.

Fuel combustion as an engineering problem. SCHOLES. *Pottery Gaz.*, **54** [619], 85–87 (1929).—The combustion of fuel as an engineering problem is dealt with, and the view that the use of larger boilers in modern industry is rendering hand-firing difficult if not indeed impossible, is advanced. There are two alternatives to hand-firing, *viz.*, the use of mechanical stokers or the employment of pulverized fuel. Both methods have strong points and are in growing competition. The main problems which face the designer of mechanical stokers are: (1) the difficulty associated with driving off the

volatile matter, *i.e.*, the coking period; (2) the necessity of reducing excess air to a minimum, and the consequent problem of arranging the air supply to suit the varying conditions of the different stages of combustion; (3) the provision of arrangements by which the interference due to clinker might be avoided; (4) the provision of means by which the rate of supply of fuel and the rate of combustion might be altered to suit the varying demands of steam production; and (5) the problem of making the mechanical stoker absolutely reliable, capable of long service, with minimum attention, and cost of upkeep. As to the rate of air and fuel supply, the depth of the fire, the rate of fuel feed, and the air pressure, all of these are capable of control in some of the more modern mechanical devices. In many designs the air supply to various zones of the furnace is independent. If reasonable intelligence and care were used, the combustion of the fuel should be carried out under excellent conditions. Tests undertaken with boilers fed with mechanical stokers had shown that it was possible to maintain for long periods high boiler efficiencies which compared favorably with those obtained by other methods of stoking and other fuels. It was evident that large boilers using coal as fuel must have mechanical stokers or turn to the use of coal in its pulverized form. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **54** [619], 87–92 (1929).—A report of the meeting at Stourbridge on Nov. 21, 1928, at which session the principal topic of discussion was "Glassworks Refractories," three papers on the subject being read by J. F. Hyslop, Percival Marson, and W. E. S. Turner, followed by an open discussion. E.J.V.

Institute of Fuel. ANON. *Chem. and Ind.*, **47**, 1266–67 (1928).—At the meeting held in London, Nov. 21, Melchett gave the presidential address. David Milne Watson is the incoming president. Regulations governing Fellowship of the Institute have been drawn up by a committee under the chairmanship of Morris W. Travers. H.H.S.

Cost accounting in manufacturing process. L. STANIFORTH. *Chem. and Ind.*, **47**, 1267–69 (1928).—Costing is discussed under the headings: raw material, labor, fuel and power, plant records, repairs and engineering stores, allocation of overhead charges, product sheets, finished products, sales tabulations. H.H.S.

Chemical engineering education. W. E. GIBBS. *Chem. and Ind.*, **47**, 1299 (1928).—An alloy of 70% chemistry and 30% engineering is regarded as a suitable mixture for a chemical engineer. H.H.S.

Testing laboratory of National Crushed Stone Association. ANON. *Pit and Quarry*, **17** [7], 45–49 (1929).—In recognition of the fact that research has become a vital activitity of their industry, the producers of crushed stone have initiated a program of investigation and have provided their national organization with the necessary facilities for research work. The laboratory is in Washington, D. C. Its aim is to obtain practical results which will be useful and valuable in solving some of the problems in aggregates with which engineers and producers are now concerned. R.G.E.

Safety and labor relations. J. M. LARKIN. *Pit and Quarry*, **17** [7], 50–52 (1929).—In a paper presented before the National Safety Congress by the assistant to the president, Bethlehem Steel Co. emphasizes the important economic position which good safety and good labor relations have come to have in business. It is necessary to do everything one can to assure to workers steady jobs, in order that their living standards may be protected or even improved and their buying and saving power uninterrupted in the best interests of the community at large. Safety is wholly noncontroversial; it is beneficial to employer and employee alike and has no negative values. Industry cannot operate efficiently and leave out safety, nor can business properly consider safety without relating it to the whole picture of the responsibility of plant operation in the most economical and efficient manner. Good labor relations mean the safety and security of ou

political, social, and economic well-being. It follows, therefore, that those who are bending their efforts to rid industry of the waste occasioned by accidents are engaged in a work that is essential to economic progress. R.G.E.

Work of Bureau of Mines on nonmetallics. ANON. *Rock Prod.*, **31** [25], 57 (1928).—The following problems now being investigated at the new Brunswick Station are outlined and progress along the several lines is reported: (1) elimination of waste in slate quarrying, (2) survey in mica industry, (3) limestone for metallurgical purposes, (4) anhydrite as a cement retarder, (5) extraction of potash from its minerals, (6) beneficiation of low-grade bauxite, (7) beneficiation of low-grade phosphate ores, (8) concentration of fluorspar ores in the Illinois-Kentucky district. F.P.H.

Bureau of Mines in the mineral field. ANON. *Pit and Quarry*, **17** [7], 57–58 (1929).—The study of measures for the safeguarding of the lives and health of the more than two million workers in the nation's mining, metallurgical, and oil and gas industries formed the major activity of the U. S. Bureau of Mines during 1928. The attainment of increased efficiency in the mining, treatment, and utilization of the country's greatly varied mineral materials, whose products are valued at more than six billion dollars annually, also occupied much of its attention. R.G.E.

Sand and gravel specifications. ANON. *Pit and Quarry*, **17** [7], 64 (1929).—The National Sand and Gravel Assn. has issued its *Bulletin*, No. 3, under the title "Representative Specifications for Different Uses of Sand and Gravel." Copies of the *Bulletin* may be had upon request by addressing the National Sand and Gravel Assn. Inc., Munsey Bldg., Washington, D. C. R.G.E.

Efficient lubrication in pits and quarries. J. A. MARTZ. *Pit and Quarry*, **17** [7], 65–67 (1929).—Lubrication of equipment is not such a difficult or intricate problem as is sometimes thought. It is, however, much too important to neglect. Today, production costs are being closely scrutinized and wastes connected with old lubrication methods are being eliminated. With proper lubrication a plant can operate with greater speed, and from 25 to 50% longer life is obtainable from each machine. It is also possible to save from one-fourth to one-half on the labor of lubricating and on the cost of lubricants. R.G.E.

Extra-high pressure steam engine at the Werkspoor Works. ANON. *Engineer*, **145**, 134–35 (1928).—The possibility of improving efficiency of central stations by addition of extra-high pressure steam plant to the existing machinery is illustrated. Improvement was realized by replacement of ordinary gear valve by Meier-Mattern hydraulically operated gear. L.A.P.

Oil engine performance on coal oils. ANON. *Engineer*, **145**, 274 (1928).—A brief summary of tests on a Mirrlees-Diesel oil engine with fuel oils derived from low-temperature processes of coal carbonization, is given. The low-temperature carbonization oils tend to be deficient in their ignition qualities. This disadvantage is offset by many advantages and it is concluded that this type of oil is distinctly better than the tar oils as a Diesel engine fuel. L.A.P.

Burning hog fuel in the Pacific northwest. O. L. LEFEVER. *Power*, **67** [6], 248–49 (1928).—Utilization of wood waste, attendant in the production of lumber, solved the problem of fuel costs in electric power generation following the war. This required furnaces different from ones used for coal and it was found that the "Dutch oven" was most suitable type for the new fuel. The most suitable design of furnace requires a large amount of brickwork adjacent the fuel pile and the maintaining of a cone height of 18 in. below the top of the furnace. L.A.P.

Operating experience with high pressure and high temperature steam. G. A. ORROK. *Power*, **67** [8], 339–41 (1928).—No serious difficulties are experienced in operation of plants using pressure up to at least 2000 lbs. per in. Alloy steels for tubes,

shells, and castings are available for more difficult operating conditions than have ever been actually experienced. There is both thermal and commercial economy in use of high pressures. L.A.P.

Priming and impurities in feed water. ARTHUR W. EWELL. *Power*, **67** [9], 370–72 (1928).—Experimental results indicate that priming is increased by the presence of acids including hydrolized salts, nondissociated substances such as sugar, slightly dissociated salts such as lead acetate, and insoluble oils. Priming is decreased by insoluble solid particles and by highly dissociated salts. This decrease is attributed to the nuclei which such particles or ions furnish for the formation of vapor bubbles. L.A.P.

Feed-water treatment retards boiler-plate embrittlement. S. W. PARR AND FREDERICK G. STRAUB. *Power*, **67** [10], 444–45 (1928).—Sodium phosphate and tannate in relatively small quantities were found to retard the embrittling action of caustic soda. Their use will perhaps avoid some of the present difficulties of maintaining a correct sulphate ratio. L.A.P.

Lime and soda treatment of feed water. E. M. PARTRIDGE. *Power*, **67** [12], 507–509 (1928).—The addition of amounts of lime and soda less than those necessary to effect complete softening may result in a more corrosive water and harder boiler scale than would have been the case had there been no chemical treatment of the water whatever. L.A.P.

Powdered coal for small boilers in industrial plants. ANON. *Power*, **67** [12], 501–502 (1928).—The power plant operator can generally improve appreciably his operating efficiency by using pulverized coal firing. L.A.P.

Vibration of turbine-generator foundations. THOMAS C. RATHBONE. *Power*, **67** [14], 588–92 (1928).—Customary efforts to avoid resonance by design are quite insufficient, most structures are too complex to predetermine that many modes of vibration, and many harmful or beneficial features affecting smooth running are too often overlooked. L.A.P.

Cutting the gas consumption of an engine. A. E. HERSHEY. *Power*, **67** [19], 814–16 (1928).—H. outlines how the adoption of the plan of closing the intake valve before the end of the suction stroke would materially reduce the fuel consumption. The plan is especially useful in operating gasoline engines on mobile equipment, including automobiles, or in any case wherein an internal-combustion engine operates at low loads and consequently at low efficiency. L.A.P.

Boiler gage glasses. BEN G. ELLIOT. *Power*, **67** [21], 901–903 (1928).—Discusses principal troubles with gage glasses, *i.e.*, breakage, glasses becoming cloudy or opaque, thinning out on top inside surface, and gasket troubles. Below 200 lbs. steam pressure, the average life is independent of pressure and depends upon local conditions. For pressures between 200 and 400 lbs. the gage glass life decreases rapidly with increasing pressure. Thinning of glass is due to glass being taken into solution by pure water. Most gasket troubles are due to improper installation. L.A.P.

Electric railway stores steam. W. MATTERSDORFF. *Power*, **68** [1], 8–9 (1928).—The possibilities of the steam accumulator, so widely used in Europe, are discussed. Stored steam is used to swing the traffic peaks. L.A.P.

Calculating central station heat-balance. E. B. HYDE AND M. A. GINGOU, *Power*, **68** [1], 12–17 (1928).—Numerous calculations are given and these are designed to save millions of dollars annually in large power station design and operation. L.A.P.

Generating industrial power. W. D. CANNAN. *Power*, **68** [4], 139–41 (1928).—Curves and data present a simple and practical method of predicting the cost of generating industrial power and a means of arriving at a fair preliminary comparison of purchased power and that made at the factory. L.A.P.

Lubrication of ball-bearings. ANON. *Abrasive Ind.*, **10** [1], 21–22 (1929).—The essential functions which a ball-bearing lubricant (oil or grease) should perform are (1) protecting the surfaces of balls and races from rust or corrosion, (2) assist in the exclusion of dirt and water by forming a supplementary seal, and (3) prevent friction between the balls and the retainer. These requirements preclude the use of all lubricants containing acid, alkali, or sulphur, which instead of protecting, would inevitably pit or etch, and thus seriously injure the highly polished surfaces of balls and races. Vegetable and animal oils are apt to gum up. The ideal lubricant for a ball-bearing is a pure neutral mineral oil or grease. E.P.R.

Collegiate salespeople. ANON. *Crockery and Glass Jour.*, **106** [18], 101 (1928).—More business can be done by applying intelligent salesmanship. The college man or woman is better suited by environment and education for selling china and glassware. E.P.R.

Embryo potters. ANON. *Crockery and Glass Jour.*, **106** [18], 127 (1928).—Two important pottery centers, Sebring and East Liverpool, Ohio, look to the future of the ceramic industry by developing through their schools technically trained students in the art of ceramics. E.P.R.

Potters meet at Waldorf. M. K. ZIMMERMAN. *Crockery and Glass Jour.*, **106** [18], 137 (1928).—Fiftieth annual meeting of the U. S. Potters' Assn. closed at the Waldorf-Astoria Hotel, New York, Dec. 5, 1928. E.P.R.

Glass distributors meet in Pittsburgh. ANON. *Nat. Glass Budget*, **44** [29], 7 (1928).—The National Glass Distributors Assn. held its 14th Annual Meeting in Pittsburgh, Pa., Dec. 4 and 5, 1928. E.P.R.

Increase in fluorspar tariff recommended. ANON. *Refract. Jour.*, **4** [39], 71 (1928). E.P.R.

Largest Bristish steam turbine. ANON. *Refract. Jour.*, **4** [39], 93 (1928).—Turbo-alternators of 90,000 H.P. have been ordered by the London Power Co. E.P.R.

Method of action of silica dust in lungs. PATRICK HEFFERNAN AND A. T. GREEN. *Jour. Ind. Hyg.*, **10**, 272–78 (1928).—SiO_3 in stable combination and crystalline SiO_2 appear to be harmless while in those states. The harmful effects of colloidal SiO_2 appear to be due to its powerful potentialities as a colloid. Pulmonary silicosis is probably caused by the colloidal action of hydrated SiO_2, formed from minute particles of SiO_2 dust disseminated through the pulmonary tissue. Substances known to coagulate colloidal SiO_2 will prevent its harmful activity in the lungs. Such substances are clay, carbon, shale dust, etc. (*C.A.*)

BOOKS

A. S. S. T. Handbook 1929. Published by the American Society for Steel Treating, Cleveland.—Fabricoid, 670 pages, supplied by *Abrasive Industry* to the members of the A. S. S. T. and Institute of Metals Division of the Institute of Mining and Metallurgical Engineers for $5.00 and to nonmembers at $7.50. Reviewed in *Abrasive Ind.*, **10** [1], 32 (1929). E.P.R.

Money Problems of Business Men. WM. B. CASTENHOLZ AND ALAN ROBERT MURRAY. Published by Schill & Co., Los Angeles; Cloth, 313 pp. Price $5.00. Reviewed in *Abrasive Ind.*, **10** [1], 32 (1929). E.P.R.

Patents, Law, and Practice. OSCAR GEIER. 4th ed. Cloth, 48 pp. Published by Richards & Geier, New York. Reviewed in *Abrasive Ind.*, **10** [1], 32 (1929). E.P.R.

American Way to Prosperity. GIFFORD K. SIMONDS AND JOHN G. THOMPSON. Cloth, 243 pp. Published by A. W. Shaw & Co. Price $3.00. Reviewed in *Abrasive Ind.*, **10** [1], 32 (1929). E.P.R.

Industrial Engineering and Factory Management. ARTHUR G. ANDERSON. Cloth, 623 pages. Published by the Ronald Press Co., New York. Price $5.00. Reviewed in *Abrasive Ind.*, **10** [1], 33 (1929). E.P.R.

Nonplastic Ceramic Raw Materials. RUDOLF NIEDERLEUTHNER. 592 pp. Price 39 RM. Julius Springer, Berlin. The book is divided into two parts, (1) a general part treating of (*a*) agents used to decrease the plasticity of bodies, (*b*) dead-burned materials, (*c*) fluxing agents, (*d*) refractory constituents of ceramic bodies; (2) a special part treating of (*a*) silica in its various forms, (*b*) aluminum compounds, (*c*) carbon compounds (graphite products and Carborundum), (*d*) alkali compounds, (*e*) lime compounds, (*f*) magnesium compounds, (*g*) barium compounds, (*h*) ashes and slags, (*i*) chromium and zirconium compounds, (*j*) rare earths, (*k*) nitrides and carbides.

F.P.H.

Underground Practice in Mining. BERNARD BERINGER. Mining Publications, Ltd., London. 255 pp. Price 20*s*. Reviewed in *Min. and Met.*, **10** [265], 48 (1929).—Many textbooks describe the different phases of underground work in a metal mine, but there is none that deals exclusively with underground efficiency. This work discusses timbering, shafts, stoping, blasting, compressed air practice, ventilation, sampling mine organization, and the practice found best after long underground experience. Attention is called to some practices that are obviously unsound. F.P.H.

Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering
TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering
TWO INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture
TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology
TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering
TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering — *Head of Department:* J. W. WHITTEMORE

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS
Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*
Founded 1927 — *Head of Department:* JOHN N. FRANK

UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIALS

PRESIDENTIAL ADDRESS[1]

BY MACDONALD C. BOOZE

It gives me a great deal of pleasure to extend, on behalf of the AMERICAN CERAMIC SOCIETY, a welcome to the representatives of the various trade associations who are here. With thanks to the Local Committee and our Secretary, who have arranged the program, this Meeting is without doubt to be one of the most successful and valuable of any that has been held by the SOCIETY.

In view of the Exposition which is being held and the attempt to further the public knowledge and interest in ceramic products in various ways, it is especially fitting that our Meeting should be held in conjunction with the associations whose members are interested in the manufacture and sale of ceramic wares. We hope that this will be the beginning of close coöperation between the associations for the betterment of the industry. The AMERICAN CERAMIC SOCIETY stands ready to assist such a movement in every way possible.

The need for joint action on some of the problems relating to the industry as a whole has been felt for some time and on several occasions.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (General Session.)

We have seen several instances of duplication of effort, which could have been averted by concerted action, cases where a single group was unable to accomplish a valuable objective and which could have been obtained by the influence of an affiliated organization representing the whole industry, and examples of what can be accomplished by such coöperative effort. From this need for concerted effort grew the idea of a ceramic council, which was tentatively proposed about two years ago and which has been approved in a general way by the trustees of THE AMERICAN CERAMIC SOCIETY. We hope that at this Meeting the idea may be crystallized and some definite action taken.

The interest of the AMERICAN CERAMIC SOCIETY in this matter is entirely in promoting the welfare of the industry at large. It has been necessary for the SOCIETY to take leadership in the promotion of the idea because no other national body existed which was interested in all branches of the industry. The SOCIETY is not seeking domination of the individual groups, nor is this desirable from any standpoint. It is available to you, however, as a central organization in contact with all of the ceramic industries and capable of being used as a clearing house for the efficient operation of such a federation as is proposed.

The question as to what may be accomplished by concerted effort on the part of all of the branches of the industry will be largely answered by some of the speakers on the program, which is to be followed. The experience of the Ohio Ceramic Industries Association in this respect is of great interest. This organization has been able to obtain funds, equipment, and favorable legislation through the influence of massed attack. It is in a very happy position today and is accomplishing things of real value to the ceramic plants in the state. We are confident that the idea can be extended broadly with equally good results. Pressure can be exerted to secure larger government appropriations for ceramic work and equitable recognition obtained, which has been lacking in the past. Tariff, legislative, and traffic matters can be dealt with better as a group than as individuals. Investigations on fundamental properties of ceramic materials and products which we are so badly in need of can be financed as a body, where individual organizations could not afford to do it, and a great deal of effort and expense can be saved by combining research programs.

This federation need not affect the normal operation of any of the existing organizations. It can be built up in a simple way and developed as the need arises. On research work alone we feel that such an organization would be well worth while and might be initially established on this basis. As a means for accomplishing this objective we offer for the consideration of the several ceramic trade associations a plan of affiliation, the general principles of which have been adopted by the American Refractories Institute and the board of trustees of the AMERICAN CERAMIC SOCIETY.

By this plan the membership in the Institute and Refractories Division of the AMERICAN CERAMIC SOCIETY is identical, although the members are graded. Both organizations continue to function, as was previously the case, and business meetings may be held apart from the technical sessions. The gain to the CERAMIC SOCIETY is in bringing into the organization the plant executives whose influence and assistance have often been needed in the past. We know that these contacts will be mutually beneficial. By such federation the Refractories Institute avoids duplication of effort, stimulates research, and increases the value of membership in the organization.

By the affiliation of other organizations in a similar way, we shall be able to set up a powerful body, whose influence can be used in a variety of ways for the betterment of the ceramic industry. We hope that you will give this serious consideration, leading toward definite action on the part of your respective organizations.

FEDERATION OF CERAMIC ASSOCIATIONS[1]

BY J. M. MCKINLEY

At no time in the past twenty years have we been in greater need of a complete orientation of our position as manufacturers in a basic industry. The much-abused term, "post-war conditions," has been applied with persistent fallacy to a long series of economic and social changes which are only the forerunners of the final structure. An appraisal of these conditions is absolutely imperative. Even a most superficial review indicates that we have entered a new and distinctly unique business cycle.

The Cape Cod Guilds are described as resisting the encroachment of small proprietorships. These proprietorships in their turn went down before a unit system from which we are now emerging into a full corporate development. While our consideration of this subject is economic, it is well here to establish the basic principle that our economics are good or bad in direct proportion to their social worth. This ceramic industry of ours is one of the great employers of American labor, and the significance of this fact must not be lost in our consideration of the merchandising problem.

What, then, is the outstanding evidence of this new cycle? You say that competition is not much worse than in many previous years; you may insist even that unethical practices have abated somewhat; and your way may be charitably inclined in your various trade associations and societies, where you eat the other fellow's salt, or explore with a competitor

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (General Session.)

the sacred purlieus of the 19th hole. I have attended many meetings in various organizations of the trade association type, and in most of them, if not in all, I would seek in vain for the answer to my query.

That answer is found in the sober consideration of the ultimate cost of your product as it is contrasted with that of your competitors. Never before has there existed so great a spread in costs of competitors opposing each other in fields limited by freight rates and consuming volume. Natural prime cost advantages cost as always, but these differences have less bearing on the case than is generally supposed. The great determining factor is the cost of sales and overhead.

In the ten-year period ending in 1916, there existed many small or medium-sized units in your allied industries which were doing business successfully with a total sales and overhead cost of 10 to 13% of total cost. Today these same concerns are spending 25 to 30% to attain the same end. Much of our present erratic competition is due to the effort of these units to offset high cost by increased production volume. That this apparently succeeds in a rare case only proves the rule that there is no relief by this method.

In our relationship as competitors we have many common problems upon which proper legal contact may be made. I am not concerned with these, because they never made or broke a balance sheet. The single problem which I here present is altering balance sheets at a rate which of itself furnishes the greatest moral and practical reason for concerted study and effort. If this is not the legitimate field of the trade association, then the trade association is worth little more than nominal consideration as an excuse for golf tournaments or pleasant dinners. If your organization is one which is handling a mass of detail, and facing no real facts, it ought to be abandoned.

The bare fact of the matter is that we are in for a very considerable realignment in most of our divisions of the ceramic industry. If we conclude that prices will rise to protect the weaker units, we have our heads in the sand. We are facing a generally declining price average of all commodities, and cannot in fairness or reason conclude that we will escape the general trend. If we conclude that some process of elimination will remove part or all of these weaker units, we underestimate the average American's ability to pull in his belt, and put up a long fight. The sane and natural conclusion is obvious.

Personal and insular prejudice must be forgotten. Our trade association must find the facts, and give them proper publicity. When it is clear that many units have the same problem expressed by the same sort of figures, we may expect a type of coöperation not hitherto obtainable. This may lead to sane production schedules. Some may develop new outlets through the expansion of research activities. Others will merge

their properties to bring them more nearly into conformity with the requirements of the times.

I have referred to the social obligation involved in association work. There remains the consideration of governmental attitude. Never in its history has the United States Government better understood the problems of the manufacturer, nor has it ever shown as clearly the desire to encourage constructive contact between business men. Let us see then that our trade organizations are kept free of influences that would tend to weaken or destroy this support.

In the face of a fundamentally sound future, let us approach this problem without wasting time on nonessential and faulty details. It is both illegal and useless to attempt control of prices. The competitive graveyard is full of such ideas, which fail because no one knows clearly what the true economic facts may be.

Nearly a year ago I proposed the federation of all ceramic associations into and with the AMERICAN CERAMIC SOCIETY, each association to retain its corporate and working identity. If the AMERICAN CERAMIC SOCIETY can grasp the significance of this proposal in its relationship to the problem I have here presented, it will have rendered indeed a most valuable service to a great industry.

OUR CERAMIC EXPOSITION AND CONCURRENT MEETINGS[1]

We had during the week of February 4, the first American Ceramic Exposition. It would be a serious oversight if certain features of the whole idea were not brought to light and this initial attempt to completion which like most initial attempts was but a start.

The exposition and group association meetings are really corollary to one another. The ideas of the exposition are:

(1) To bring the various brothers of the big family of ceramic industries together.

(2) To develop a ceramic consciousness among the public.

(3) To demonstrate the importance and superiority of ceramic products in everyday life.

(4) To impress the public with the fact that America does not lag in quality, beauty, and utility of ceramic products.

(5) To have something around which could be built a publicity campaign through the daily press and radio that would enable the ceramic industries to get a valuable message across to the public at a very low cost and in a very effective way.

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (General Session.)

(6) To inform the ultimate purchasers as well as the store buyers, jobbers, etc.

The ideas in back of the allied ceramic association meetings are:

(1) To line up a billion dollar industry whose size and importance in payroll, value of property, and value of products will be impressive to and respected by:

(*a*) Legislative and other government agencies, in matters of tariff, building code work, prison labor plants, research,

(*b*) The general public so that it will endorse and hold good-will toward measures of protection and broadening the ceramic industries.

(2) To save time and expense among ceramic and clay products manufacturers by enabling them to attend their various association affairs in one trip.

(3) To take advantage of interchange of ideas among a greater number and between themselves and equipment and supply manufacturers at the exposition.

Some objectives of this plan have already been achieved, some partly, and some await further action.

That a ceramic consciousness among the public has been created is certain from the reaction noticed as a result of the newspaper and radio publicity. The depth and breadth of this ceramic consciousness is limited only to the amount of funds available. Hundreds of newspapers from Oregon to New York told about the advances made by American ceramic scientists in equalling the product of any foreign nation. Moreover, radio programs on four different stations told a message that is valuable to the interest of ceramic products. The press publicity, the radio messages, and the exposition will be a continuing potent force in merchandising.

The bank windows and store windows had interesting exhibits and the street cars in Chicago carried announcements relative to the American Ceramic Exposition.

When it is considered that a larger exposition would be more attractive, demonstrative, and revenue producing, it is obvious that this pioneer attempt is but a sample of what could be done if a larger group of manufacturers coöperated. Through the support of the machinery and supply firms, the local committee was enabled to carry out to a limited degree the plan as conceived, and therefore it is only fitting and proper at this time to call the attention of all ceramic and clay products manufacturers to the debt of gratitude owed to those who supported this Exposition.

To the Chicago Committee unstinted praise and thanks have been spoken and written for having successfully put over this Ceramic Week.

The American Ceramic Week of February 4 to 9, inclusive, in Chicago proved the value of ceramic associations holding concurrent meetings.

The Chicago Committee and the Association secretaries are grateful for the unanimity in spoken praise of the events and the programs.

Presumably, only the Association secretaries and their staffs saw wherein the programs could be bettered and more economically merged. The secretaries saw the conflict in schedules and the weak spots in the management. The praise unstintingly given for the Ceramic Week program as conducted makes the secretaries wonder how much more favorably the delegates would have been impressed had the Ceramic Week events been as we now know how they should and can be synchronized.

Economy in traveling and in time; a larger number of men engaged in similar work with whom to exchange ideas; a greater amount of information and inspiration from the larger, more varied, and much better programs are some of the direct benefits to those attending.

The indirect benefits to the ceramic industries are expressible in large financial returns; savings in research expenses by elimination of duplication; securing of larger appropriations by federal and state governments for ceramic research; directing in a larger degree to ceramic research the university facilities now being employed without cost by manufacturers of competitive products; and the securing of rights and benefits in legislative matters for ceramics which are securable only through concerted representation of the ceramic industries without regard to character of product—these are the benefits which will accrue when the several associations will learn how to hold concurrent meetings, and to work together in full faith and mutual confidence.

There were over 1800 delegates in Chicago, over 1700 registered. Over eleven hundred railroad certificates were validated for one-half fare return trip. The exposition gate showed over 70,000 visitors in addition to the convention delegates and exposition attendants. "Some meeting, and how." It should be repeated.

ACTIVITIES OF THE SOCIETY

OFFICERS OF THE AMERICAN CERAMIC SOCIETY FOR 1929–30

Board of Trustees

President:	George A. Bole, Lord Hall, O. S. U., Columbus Ohio
Vice-President:	F. A. Harvey, Harbison-Walker Refractories Co., Pittsburgh, Pa.
Treasurer:	H. B. Henderson, Standard Pyrometric Cone Co., 1538 N. High St., Columbus, Ohio
Secretary:	Ross C. Purdy, 2525 N. High St., Columbus, Ohio
Past Presidents:	B. Mifflin Hood, B. Mifflin Hood Brick Co., Atlanta, Ga.; M. C. Booze, Chas. Taylor Sons Co., Cincinnati, Ohio
Division Trustees:	(*Art*) E. deF. Curtis, Conestoga Pottery, Wayne, Pa.; (*Enamel*) B. T. Sweely, Baltimore Enamel & Novelty Co., Box 34, Baltimore, Md.; (*Glass*) C. D. Spencer, General Electric Co., Nela Park, Cleveland, Ohio; (*Heavy Clay Products*) Geo. W. Denison, Ohio Clay Co., 8829 Broadway, Cleveland, Ohio; (*Refractories*) J. M. McKinley, Crescent Refractories Co., Curwensville, Pa.; (*Terra Cotta*) Ercill C. Hill, Conkling-Armstrong Terra Cotta Co., Wissahickon Ave. & Juniata St., Philadelphia, Pa.; (*White Wares*) Edward Schramm, Onondaga Pottery Co., Syracuse, N. Y.

Division Officers

ART:

Chairman: E. deF. Curtis, c/o Conestoga Pottery, Wayne, Pa.; Secretary: Marion L. Fosdick, Alfred University, Alfred, N. Y.

ENAMEL:

Chairman: J. E. Hansen, Ferro Enameling Co., 2100 Keith Bldg., Cleveland, Ohio; Secretary: W. V. Knowles, Titanium Alloy Mfg. Co., 6007 Euclid Ave., Cleveland, O.

GLASS:

Chairman: Dr. J. T. Littleton, c/o Corning Glass Works, Corning, N. Y.; Secretary: G. W. Morey, Geophysical Laboratory, Washington, D. C.

HEAVY CLAY PRODUCTS:

Chairman: Ellsworth P. Ogden, Consulting Ceramist, 1957 Chelsea Rd., Columbus, Ohio; Secretary: Howells Fréchette, Mines Branch, Dept. of Mines, Ottawa, Canada.

REFRACTORIES:

Chairman: E. H. Van Schoick, Chicago Retort & Fire Brick Co., Ottawa, Illinois; Secretary: Miss Dorothy A. Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

TERRA COTTA:

Chairman: Samuel J. McDowell, Corning Terra Cotta Co., Corning, N. Y.; Secretary: H. D. Callahan, Northwestern Terra Cotta Co., 2525 Clybourne Ave., Chicago, Ill.

WHITE WARES:

Chairman: R. F. Sherwood, c/o Pass & Seymour, Solvay Station, Syracuse, N. Y.; Secretary: E. H. Fritz, Westinghouse High Voltage Insulator Co., Derry, Pa.

OUR NEW PRESIDENT

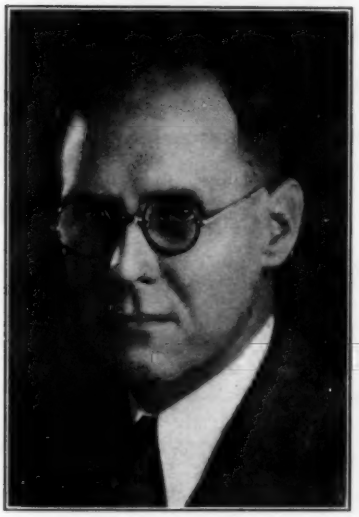
George Addison Bole[1] has been elected president of the AMERICAN CERAMIC SOCIETY because of his intimate experiences in the ceramic development work and in the research agencies which the members of this SOCIETY have been promoting.

[1] For biography see *Bull. Amer. Ceram. Soc.*, **8** [12], 373 (1928).

As professor of chemistry at Alfred University, superintendent of Columbus Station Bureau of Mines, research professor at Ohio State University and secretary of the Ohio Ceramic Industries Association he has had an unusual opportunity to know the possible benefits of federated coöperation in research.

It seems strange that our ceramic manufacturers do not realize the combined financial and labor employing magnitude of ceramics in America. The reason for this lack of realization of the industrial bigness of ceramics in America is the great difference in character and use of the different ceramic products.

Our manufacturers have organized into trade associations, an association for each distinct product. This has dispersed the interest and support which the ceramic in-



GEORGE A. BOLE, President

FRED A. HARVEY,[2] Vice-President

dustries must be giving to the federal and state research institutions. The managers of our ceramic industries must realize the industrial bigness of ceramics in America and unite in efforts to so impress this that they can have research done in these public institutes, proportionate to the supporting taxes paid by the ceramic industries.

Since the AMERICAN CERAMIC SOCIETY is the only national organization interested alike in all ceramic products and devoted to the promotion of the ceramic arts, science, and technology, it is essential that the officers and committeemen of the SOCIETY shall have the most intimate knowledge of the research resources of America.

It is expected that Professor Bole, as president of this SOCIETY, will do much toward federating the several types of ceramic industries into a united force for ceramic research.

[2] For biographical sketch and activities in the AMERICAN CERAMIC SOCIETY see *Bull. Amer. Ceram. Soc.*, **7** [12], 373(1928).

NEW MEMBERS RECEIVED FROM JANUARY 1 TO FEBRUARY 1

CORPORATION

London Brick Co. and Forders, Ltd., Brickmakers, Africa House, Kingsway, London, W. C. 2.

Samuel Stamping and Enameling Co., Chattanooga, Tenn., W. L. Lane, Representative.

Ukrsilikattrust, The Ukrainian Silicate Trust, preparation of rough ceramic ware, Ul. Lwanowa 27, Kharkov, U. S. S. R., Zinovy Tabakov, president.

PERSONAL

Leason H. Adams, 2801 Upton St., Washington, D. C., Physical Chemist, Geophysical Laboratory.

Mrs. Alexander Archipenko, 16 West 61st St., New York City, École d'Art.

Otto Becker, 1001 Hyslop Place, Hammond, Ind., Plant Engineer, Harbison-Walker Refractories Co.

Harry E. Cave, 2120 Natchez Ave., Chicago, Ill., Vice-President, General Color Products Co.

R. D. Chandorkar, Paisa Fund Glass Works, Talegaon Dabhade, Dist. Poona, India, Superintendent.

Altana M. Claire, 1656 E. 118th St., Cleveland, Ohio, Instructor in ceramics and art.

Howard H. Craver, Manager, Pittsburgh Testing Laboratory, Stevenson and Locust Sts., Pittsburgh, Pa.

William Charles Cummings, 42 Moore St., Carleton Place, Ontario, Enamel Foreman, Findlay's Bros.

Robert F. Cuyler, General Mgr., Michigan Clay Products Corporation, Williamston, Mich.

Ingraham Humphrey, 238 West 5th St., East Liverpool, Ohio, Ceramic Instructor.

Charles Ingram, Clinchfield Sand and Feldspar Corp., 430 Hearst Tower Bldg., Baltimore, Md.

Frederick Hursh Johnson, Secretary-Treasurer and Sales Representative, The Summitville Face Brick Co., Summitville, Ohio.

Walter B. Kruse, 102 Concordia Place, Fort Wayne, Ind., Process Engineer, General Electric Co.

Horace Kephart Lynn, President and Plant Manager, Summitville Face Brick Co., Summitville, Ohio.

James L. McFarland, Industrial Heating Dept., General Electric Co., Schenectady, N. Y.

Henry Duncan McLaren, 2026 Abington Rd., Cleveland, Ohio, Chemist, Ferro Enameling Co. of Canada, Ltd., Ottawa, Ont.

Willard L. Morgan, Director of Research, Triplex Safety Glass Co. of North America, Clifton, N. J.

John Maxwell Neff, 825 Columbus Apts., 50 Chestnut St., Rochester, N. Y., Ceramic Engineer, Bausch and Lomb Optical Co.

Robert W. New, Hamilton Pressed Brick Co., Ltd., Kensington Ave., S., Hamilton, Ont., Can.

V. S. Phadake, Sorab Dalal Tile Works, Than Road (Kathiwar) India, Ceramist (interested in pottery).

Herbert E. Primm, Ceramic Engineer, Harbison-Walker Refractories Co., East Chicago, Ind.

H. LeRoy Radway, Superintendent, Vitreous Enameling Co., 6700 Grant Ave., Cleveland, Ohio.

John A. Richardson, General Superintendent, Kalamazoo Sanitary Mfg. Co., Kalamazoo, Mich.

Frank W. Salisbury, Durant City, Elk County, Pa., Superintendent American Plate Glass Corp.

Ernst Hermann Schulz, Aachener Str. 22, Dortmund, Germany, Direktor des Forschungs Instituts der Verein Hellwerke, A. S.

Juan Maiza Simavilla, Quimico Industrial (glass) Berazategui, F. C. S., Argentina, S. A.

James E. Skirvin, Ceramic Engineer, General Refractories Co., Olive Hill, Ky.

Samuel Stevenson, 1822 S. 58th Ave., Cicero, Ill., Superintendent, General Color Products Co.

Stanley Warner, 430 S. Crest Rd., Chattanooga, Tenn., Superintendent, Enameling Dept., Samuel Stamping and Enameling Co.

Freeman S. Webb, District Manager, General Refractories Co., Olive Hill, Ky.

O. B. Westmont, Research Chemist, The Celite Corporation, Lompoc, Calif.

Artur Zwetsch, Assistant Manager, Sanitary Fireclay Works, Ratingen, Germany, Landstrasse 3a.

STUDENTS

John E. Musselman, Ohio State Univ., Columbus, Ohio.

Clifford McIntosh Nicholson, Univ. of Saskatchewan, Saskatoon, Sask., Can.

Willard Edison Palmer, Ohio State Univ., Columbus, Ohio

Delos H. Wamsley, N. Y. State School of Clayworking and Ceramics, Alfred, N. Y.

Charles C. Westall, Univ. of Illinois, Urbana, Ill.

Carl Henry Zwermann, Jr., Univ. of Illinois, Urbana, Ill.

Membership Workers' Record

Corporation		Personal		Students	
Office	3	M. G. Ammon	1	R. K. Hursh	1
		A. A. Ayars	1	S. Mathews	1
		J. W. Cruikshank	1	A. S. Watts	1
		E. deF. Curtis	1		–
		R. F. Ferguson	1		3
		F. M. Hartford	1	Grand Total	38
		A. R. Heubach	1		
		G. C. Keith	1		
		S. B. Larkins	2		
		C. C. Leigh	1		
		W. D. Mavor	2		
		R. D. Rudd	2		
		M. R. Scott	1		
		A. L. Simison	1		
		J. G. Tait	1		
		C. Thompson	1		
		L. J. Trostel	2		
		Office	11		
		Total	32		

LOCAL SECTION MEETINGS

Pittsburgh Section

The Pittsburgh Section has arranged a program of varied interest for the first half of 1929. The March meeting, which will be held at the Mellon Institute on Tuesday evening, March 12, will be addressed by Ross C. Purdy on the subject of abrasives. For the April meeting which is scheduled for April 18 at the Pittsburgh Bureau of Mines the Section will have for guest speaker M. C. Booze, Vice President of the Charles

Pacific Northwest Section Meeting

Taylor Sons Company of Cincinnati. The May meeting will be correlated with the visit of the British ceramists. It is planned to hold the June meeting in East Liverpool with an address by F. H. Riddle of the Champion Porcelain Company, Detroit, Mich.

Pacific Northwest Section[1]

The largest and most interesting meeting of ceramic men was held in Seattle, Washington, Jan. 18 and 19, 1929, as a combination of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY, the P.N.W. Brick and Tile Association, and the P.N.W. Clayworkers' Association. It plainly showed the great interest in ceramic products and the increasing expansion of the ceramic industries in the North Pacific states.

Two meetings were held simultaneously on Friday afternoon. The Brick and Tile Association met at the Olympic Hotel for a discussion of the sales and promotion of clay products. The principal speaker was R. G. Mairn, Coast Engineer of the Common Brick Manufacturers' Association with headquarters at San Francisco, who spoke on "Earthquake Insurance Rates." W. J. Howard, secretary of the local section, reviewed the work of the year in the Pacific Northwest states.

At the same time the technical men were holding a meeting at the new Physics Building on the University of Washington campus, with President W. E. Lemley presiding. The following program was given:

(1) "Testing of Ceramic Kilns in the Pacific Northwest," by Howard Mansur. This was a review of Mr. Mansur's work in testing sewer pipe, terra cotta, fire brick, and face brick kilns of both the continuous fire moving types and the periodic systems. Comparisons were made between the efficiency of the continuous and periodic kilns.

(2) "A Peculiar Discoloration of a Terra Cotta Glaze," by T. E. Nicholson. This is a dark, gray-brown smoky discoloration which affected a high manganese oxide glaze and was eliminated by altering the glaze composition, controlling the thickness, and watching the manganese.

[1] Hewitt Wilson, *Secretary*.

(3) "Kaolin Mining and Preparation in Florida, North Carolina, and Georgia," by Hewitt Wilson. An illustrated description of the deposits and methods of treatment used for pottery and paper china clays.

(4) "The Ceramic Industry in California," by W. E. Lemley. An account of the novel features used by some of the California companies in the manufacture of roofing tile to imitate the hand-made tile of the old Mexican missions by mechanical methods and the production of the decorative faience tile.

(5) "An Instrument for Measuring the Thickness of Terra Cotta Glazes," by A. L. Bennett. This was a paper sent from Los Angeles by Mr. Bennett on request of the Local Section here and read by Dan D. Wheeler. It is a description of the instrument in use by the Gladding McBean plants for determining the thickness of the glaze coatings before firing.

The meeting was adjourned for dinner at the University Commons but was continued around the table later on the subjects of:

(6) "The History of the Early Pottery, Brick and Tile, Sewer Pipe, Terra Cotta, and Firebrick Manufacture in Washington."

(7) "The Bulging of Fireclay Shapes," by G. B. Richardson. This is a universal problem in the manufacture of thick refractory block and was discussed from the standpoint of molding, pressing, turning-out of the mold, drying, edging, firing, and air pockets.

It was decided that two meetings a year were not sufficient for the ceramic group in the Pacific Northwest and that evening meetings at more recent intervals would be tried this year. The next will probably be held March 7.

A general meeting of the three associations was held Saturday afternoon at the University of Washington, with President W. E. Lemley presiding.

The report of the fellowship committee was accepted and it was decided to solicit funds to maintain a research worker in the Ceramic Engineering Department of the University of Washington for the purpose of standardization and testing of various manufactured products of the Pacific Northwest. This research work will probably start about July 1, 1929.

The program followed:

(1) "Address of Welcome," by Milnor Roberts, Dean of the School of Mines.

(2) "The History of Clay Products in Architecture," by A. P. Herrman, Professor of Architecture, University of Washington.

(3) "The Geological History of Western Washington," by C. E. Weaver, Professor of Paleontology, University of Washington.

(4) "Terra Cotta Problems," by Paul S. MacMichael, Gladding McBean and Co.

The grand finale of the two days' meeting was the stag dinner held at the Via Fontona dining room of the Wilsonian Hotel. Numerous skits, Scotch stories, kept the group in an uproar most of the evening. Bill Bowman with his clever, fast hands bewildered everyone with his mysterious rope, card, cigarette and napkin tricks. The final act, written by Clifford Houlahan and Albert Armstrong, was the big treat of the evening. Five brick salesmen tried to sell a prospect with their five different brands of face brick and so successfully belabored each other that stucco was finally chosen, with a moral. The local textured or "Tex" brick were features of the playlet.

The brick manufacturers were given a three-hour ride around Seattle to show them the rapid expansion of brick homes within the last few years. The number per year has increased from about 5 brick homes in 1925 to over 400 in 1928.

Partial Attendance List

Dan D. Wheeler, Seattle
W. Wurth Kreigel, Seattle
J. A. Cunliffe, Vancouver, B. C.
H. E. Clem, Seattle
Robert Coats, Seattle
H. H. Mansur, Taylor
H. S. Davis, Seattle
K. A. Johnson, Seattle
A. N. Johnson, Seattle
T. E. Nicholson, Auburn
Wallace Thoreson, Clayton
L. A. Martin, Renton
Fred Kettenring, Jr., Vancouver, Wash.
Robert L. Thorne, Renton
John D. Scott, White Horse, Y. T., Canada
Vernon B. Pratt, Ferndale
W. R. Green, Spokane
Ralph L. Jones, Seattle
John P. Denison, Seattle
Silas Rich, Seattle
Sam Geijsbeek, Seattle
J. B. Millar, Mission City, B. C.
J. A. Millar, Vancouver, B. C.
W. E. Lemley, Taylor
H. K. Benson, Seattle
Hewitt Wilson, Seattle
G. B. Richardson, Seattle
Joseph Daniels, Seattle
Milnor Roberts, Seattle
J. H. Yates, Seattle
C. M. Brasfield, Seattle
Foster Hidden, Vancouver, Wash.
S. H. Geijsbeek, Renton
Gregory L. Rogers, Renton
J. R. Miller, Seattle
Paul S. MacMichael, Seattle
E. E. Saunders, Spokane
Arthur Houlahan, Seattle
J. Geo. Adderson, Renton
F. T. Houlahan, Seattle
Henry Hoffman, Seattle
H. R. Kreitzer, Portland
P. F. Lingren, Portland
Alex H. Corbett, Yakima
J. B. DeGolyer, Jr., Seattle
J. B. Campbell, Seattle
H. P. Hassell, Seattle
Elliott Brown, Renton
H. G. Penman, Seattle
V. L. Nielsen, Seattle
C. E. Weaver, Seattle
Arthur P. Herrman, Seattle
Philip Corbett, Corvallis, Ore.
Geo. Ramsey, Seattle
C. E. Jensen, Seattle
A. H. Wethey, Jr., Portland
J. A. P. Henderson, Seattle
J. C. Johnson, Seattle
E. K. McQuarrie, Seattle
James Akerly, Seattle
E. F. Goodner, Seattle
Robt. A. Hidden, Vancouver, Wash.
W. J. Howard, Seattle
R. G. Mairn, San Francisco

A total of about 75 attended the meetings.

OBITUARY

Arthur Raymond Payne

A. R. Payne, Chief Chemist of the Fostoria Glass Company, died suddenly at his home in Moundsville, West Virginia, on December 26, from heart attack. The deceased was born in the State of Illinois in 1891, received his B.Sc. degree from Pomona College, Claremont, California in 1913, and the M.Sc. degree from the University of California in 1914. He majored in physics and was an outstanding student. He excelled in athletics, especially in broad and high jumping. For two years after graduation he taught school, and from 1917 until 1919 he was connected with the U. S. Bureau of Standards, as physicist, and was in charge of inspection of the optical glass for the Bureau during the war. He joined the Hazel-Atlas Glass Company as chief physicist in 1919, and was appointed chief chemist of the Fostoria Glass Company about two years ago.

ARTHUR R. PAYNE

Mr. Payne took a prominent part in the activities of the Glass Division of the AMERICAN CERAMIC SOCIETY, of which he was chairman in 1923; and for

1927–28, 1928–29 served on the Standards Committee of the SOCIETY. He was also a member of the Physical Society. His thorough knowledge of glass technology, his keen analytical mind, and his fine personality made him one of the foremost members of the Division.

Mr. Payne's death was the last one to come to the SOCIETY during 1928. He was active, far seeing, and ever willing to do team work on committees as a Division officer and as a program contributor. He gave thought to the possible scope of service which this SOCIETY could render and he worked wisely and patiently to this end. His work was the sort which makes for the success of this coöperative enterprise. It is such constructive work as was rendered by Arthur Payne that makes this SOCIETY worth while.

Resolutions were passed during a session of the Glass Division at the Chicago Meeting of the AMERICAN CERAMIC SOCIETY, February, 1929, as follows:

Resolved, That the Glass Division extend a vote of respect to Mr. Payne who has been one of the Division's most active, interested, and loved members.

Copies of the resolution were forwarded to Mrs. Payne. Besides his wife, a daughter, Betty, nine years old, and a son, Robert, four years old, survive him.

AMERICA'S FIRST CERAMIC EXPOSITION

Under the auspices of the Associations that held concurrent meetings in Chicago during the week of February 4, there was held an Exposition of Ceramic Products, Equipment, and Materials. It was under the direct management of the Chicago committee. Its conception, character, and success were due to the efforts of this committee.

An exposition cannot be held without exhibitors, and the expense, labor, and time required to put up an exhibit are large. It required a real interest and a gambler's faith and expectancy to take space in the first exhibit.

We are glad that the results justified the extensive plans and labor of the local committee in charge. We are grateful to the following exhibitors who gave such magnificent support to this venture. We are proud that the exposition proved highly profitable to the individual exhibitors and to the enterprises for which it was planned.

What the Ceramic Products Exhibits Contained

THE AMERICAN ENCAUSTIC TILING CO., LTD., New York, N. Y., exhibited wall and floor tile, faience tile, a section of a glazed rail, and a beautiful polychromed plaque.

THE BENJAMIN ELECTRIC MFG. CO., Chicago, Ill., exhibited a variety of white, colored, and stenciled enamelware. Ice boxes, an electric stove, acid-resistant table tops with drop leaf, juvenile furniture, reflectors, large flat sheets, and kitchen specialties were included.

THE CAMBRIDGE GLASS CO., Cambridge, Ohio, presented attractive glass tableware in a great variety of delicate colors.

THE CERAMIC INDUSTRY OF ONTARIO presented an exhibit by the Ontario Department of Mines, Toronto, Canada, with the coöperation of the Canadian National Clay Products Assn. It consisted of various raw materials and finished products, incorporating their use, such as brick and allied products, glassware, enamelware, pottery, and electrical porcelain.

CARR-LOWRY GLASS CO., Baltimore, Md., exhibited illuminated colored glassware and small colored containers.

CHAMPION PORCELAIN CO., Detroit, Mich., displayed refractory shapes, spark plugs, chemical ware, some raw materials used in their manufacture, and also showed the various stages involved in the making of a spark plug and casserole. A machine demonstrating the strength of their spark plug was shown.

CHICAGO BRICK EXCHANGE illustrated the effective use of common brick. A modern home front of common brick and a clinker brick garden wall were shown. A bronze certified brick was inserted in the wall of the house. Samples of common brick of various members of the exchange were on display.

COLUMBIAN ENAMELING & STAMPING CO., Terre Haute, Ind., displayed a variety of colored enameled kitchenware. The processes involved in the manufacture of their percolator, from the stock to the finished product, were shown.

COONLEY MFG. CO., Chicago, Ill., exhibited enameled kitchenware in various colors.

CRAFTMAN'S EXHIBIT consisted chiefly of an art pottery display contributed by various individuals and certain ceramic schools. Polychromed plaques and stained art glass were also shown.

CHICAGO FACE BRICK ASSN. had panels of face brick in various colored mortar joints supplied by its members. Smooth and rough textured brick in a variety of colors, enameled and salt glazed brick were on display.

FOSTORIA GLASS CO., Moundsville, W. Va., exhibited several tables of glass tableware in pleasing colors.

THE HAEGER POTTERIES, INC., Dundee, Ill., had a booth containing art pottery in a variety of shapes and colors.

HAZEL ATLAS GLASS CO., Wheeling, W. Va., exhibited a very large assortment of plain and colored food containers in many sizes and shapes.

STRUCTURAL CLAY TILE ASSN., Chicago, Ill., displayed building tile in various shapes, sizes, and methods of construction, salt glazed tile for housing underground cables, and salt glazed wall tile.

HOMER LAUGHLIN CHINA CO., Newell, W. Va., exhibited white and ivory semi-vitreous dinnerware in several shapes and colors.

HULL HOUSE, Chicago, Ill., demonstrated hand molding of figures and vases. Over-glazed ware of this type in a variety of colors was shown.

LENOX, INC., Trenton, N. J., had a display of porcelain tableware, mostly decorated with gold. The $1000 service plate, the President and Embassy sets, and the George Washington dishes were of special interest.

LUDOWICI-CELADON CO., Chicago, Ill., showed an old English house with an artistic weather-beaten roof. Several plaques of roofing tile were shown with rough textured surface, resembling very closely the weather-worn roofs of England.

D. E. MCNICOL POTTERY CO., Clarksburg, W. Va., displayed plain and colored vitreous china tableware.

MIDLAND TERRA COTTA CO., Chicago, Ill., exhibited plaques of terra cotta from several building fronts.

MOSAIC TILE CO., Zanesville, Ohio. Colored wall, floor and faience tile decorated the booth. A tile fountain, rich in color, and a fireplace were also on display.

NORTHWESTERN TERRA COTTA CO., Chicago, Ill., had a beautiful terra cotta front in green, light blue, and black. Plaques of terra cotta from building fronts were shown. A terra cotta door front was also shown.

ONONDAGA POTTERY CO., Syracuse, N. Y., had a large display of vitreous hotel china and household tableware, in many decorative designs.

OHIO CERAMIC INDUSTRIES ASSN., Columbus, Ohio, showed various views of its experiment station, and exhibited a machine for adding electrolytes into pug mills.

POPE-GOSSER CHINA CO., Coshocton, Ohio, displayed semi-porcelain dinnerware in ordinary and modernistic design.

PORCELAIN TILE CO., Chicago, Ill., exhibited colored enameled sheet iron tile.

POSTON-SPRINGFIELD BRICK CO., Springfield, Ill., showed plaques of face brick with various colored mortar joints in different textures and colors.

POTTERY AND ENAMEL EDUCATIONAL EXHIBIT. The pottery exhibit was under the direction of the Lewis Institute Ceramic Department. Work on the potter's wheel and the casting of slip was demonstrated. Art pottery, plaques of test glazes, and a tiled fireplace made by the students of the department were shown. In addition, Indian pottery and that of a few potteries were on display.

The enamel exhibit was directed by the CHICAGO VITREOUS ENAMEL PRODUCT CO., in coöperation with several enameled ware manufacturers. A demonstration was given by the Chicago Vitreous Enamel Product Co. in the application and the firing of colored enamel on the base metal. The equipment used consisted of spraying apparatus and a small muffle furnace. The finished enameled products shown were ice-boxes, stoves, gas ranges, washing machines, and a combination kitchen cabinet, stove, ice-box, and sink.

A color tree was also shown, illustrating the variations of the different colors which can be secured in enamels. Its construction was such to indicate the gradual change of color from the basic to the saturated one.

SCAMMEL CHINA CO., Trenton, N. J., exhibited vitreous china tableware with various color decorations.

SEBRING POTTERY CO., Sebring, Ohio, displayed dinnerware and art pottery.

STARK BRICK CO., Canton, Ohio, had a wall of salt glazed face brick in several shades and in various shapes.

STEUBENVILLE POTTERY CO., Steubenville, Ohio, showed decorative dinnerware.

VITROLITE CO., Chicago, Ill., exhibited many colored panels of structural glass. Modernistic two-color and polychrome panels were shown. A bathroom section, table tops, and a soda fountain illustrated the use of the product.

S. A. WELLER POTTERY CO., Zanesville, Ohio, exhibited two samples of their first art pottery made in 1872. Several tables of decorated art ware, an urn, and a fountain of modern design were shown.

YESCHEK, INC., Chicago, Ill., displayed art pottery and glassware, illustrating the use of their decorations.

What the Industrial Exhibits Showed

FATE-ROOT-HEATH CO. New YF brick machine, designed for making brick by the Young Facing Process, and a number of brick made on one of these machines were displayed. Complete information on locomotives, featuring Type TL, weighing 2½ tons, Type RL, 3½ tons, Type FL, 5 tons, Type DLC, 8 tons, and pamphlets and bulletins describing complete line of clay working machinery were available. *Representatives:* F. T. Buzard and R. M. Nelson.

CATERPILLAR TRACTOR CO. Illustrated literature showed use of caterpillar tractor in brick plants, as well as photographs of installations in various fields of manufacture. The versatility of this machine and its wide field of usefulness in practically every industry in the country were shown. *Representative:* O. E. Andren.

BATES VALVE BAG CORP. The latest in design of paper bags as waterproof containers for clay, cement, and other ceramic products was shown.

RICHARD DUDGEON, INC. Photographs and model displays of the Dudgeon tunnel kiln car pusher and hydraulic jack were shown. Descriptive matter, concerning the company's products, was also distributed.

H. C. SPINKS CLAY CO. Various products produced were displayed. A miniature, mining, and clay preparation plant were laid out. *Representatives:* Thos. Rodgers and R. B. Carothers.

MUELLER BROS. Machinery was exhibited and descriptive matter distributed.

THE ABRASIVE CO. This exhibit consisted of a number of various grinding materials and implements used for smoothing off work in various branches of the ceramic industry. Photographs were shown, and literature describing the company's products was distributed.

HINDE & DAUCH CO. This company featured the corrugated packages produced by Hinde & Dauch Co., and showed the manifold ways in which to safely pack ceramic ware in cartons.

MERRITT PRODUCTS CO. Showed destruction of unprotected steel surfaces by products of combustion on clay plants in comparison with protection afforded by Opalite. Portions of drier cars, palettes, steel test plates, and angle irons protected by Opalite and subjected to severest conditions in Chicago brick plants. Also parts of unprotected drier cars, palettes, etc., destroyed by gases in 12 to 18 months. Demonstrations of the acid- and heat-resisting, waterproofing qualities of Opalite. Cassity-Richards, Inc., shared booth and had expert industrial maintenance engineers. *Representatives:* O. A. Prunner, Sr., O. A. Prunner, Jr., I. H. Cassity, and H. Richards.

CERAMIC COLOR & CHEMICAL MFG. CO. This booth contained an exhibit of raw materials, which included colors for all types of ceramic ware, as well as finished products on which these colors have been used, such as enameled signs, enameled cooking utensils, stove parts, and pottery and glassware of various types. A feature of this display was a map of the United States of porcelain enamel, using 48 different colors.

E. M. FREESE & CO. Photographs and literature covering this company's line of clay machinery, showing installations in some of the high-grade plants manufacturing brick and other clay products.

CROSSLEY MACHINE CO. Miniature machinery in operation showing power tile presses, lawns, dust blowers, and other miniature machinery of interest to tile and porcelain manufacturers, as well as the general pottery trade. *Representative:* Fred V. Drake.

BUCYRUS-ERIE CO. Featured a transparency case with some 60 pictures of installations of Bucyrus-Erie Shovels in clay pits in various parts of the country. These pictures were transparent and lighted from the back with a bluish green light. Unusual and interesting clay pits were on display.

JOHNS-MANVILLE CORP. The display consisted of high-temperature insulation products, including products of Celite Products Co.; refractory cement, asbestos rope for expansion joints, leer rolls of "Electrobestos," pipe covering, waterproofing, asbestos siding for factory buildings, friction blocks for hoists, packings, and other J-M products. *Representatives:* H. Haberstroh, G. H. Davis, F. W. Decker.

INTERNATIONAL CLAY MACHINERY CO. Full-size drier car of the latest type, as well as enlarged photographs of the new Type 485 and 475 straight-line machines, and the new Type 425 double reciprocating feeder, single machine, as well as various other equipment manufactured were shown.

EAGLE IRON WORKS. Complete descriptive matter covering Eagle dry pans, wet pans, double roll preliminary crusher, "Allen-Denison" cutter, and shale planer was distributed. Various photographs showed the use of this equipment in clay products plants. *Representatives:* T. Aulmann and C. B. Laird.

WILLIAM W. STANLEY CO., INC. Full line of press cloths of various weaves and finishes, including the "Kopper Klad" and "Artex" metallic coated-surfaced pottery filter cloths and a wide variety of various styles of filter-press cloths of different weaves were shown. Strength and breaking points of various fabrics were demonstrated by mechanical tests. *Representatives:* Andrew R. Peer.

THE BONNOT CO. A variety of photographs, showing a large number of clay plant installations, using Bonnot equipment. Among these are some of the finest plants in the country, manufacturing the highest grade of heavy clay products. Circulars and printed matter were distributed.

NEWARK WIRE CLOTH CO. Wire cloths of all weaves, metals, and meshes for all ceramic purposes were shown. Monel metal was featured, and the world's finest 400-mesh cloth shown. There were also the latest developments in testing sieves. *Representatives:* E. S. Webster and E. G. Nichols.

C. & G. POTTS & CO. Pictures showed latest design Semi-Automatic, Horizontal Brick Machine. Catalogs and other literature were distributed. *Representatives:* H. D. Caylor and Geo. Potts.

PAPER MAKERS IMPORTING CO., INC. Exhibited clays from the crude to the refined article as shipped to the potters of America. Pictures showed mines and the production of clay, loading and shipping from the other side, and the unloading from ship onto cars in America. *Representatives:* Geo. Brian, E. H. Smith, and Chas. Brian.

BAKSTAD CRUSHER & EQUIPMENT CORP. Cross-sectional model of the 3-jaw crusher, constructed to show all component parts and assembly. This model, by turning the fly wheels, reproduces exact crusher jaw action. Samples of various materials, crushed to various degrees of fineness with the patented 3-jaw crusher, were shown. Pictures of crusher construction and crusher installation were on display. *Representatives:* J. R. Bakstad and R. L. Irvin.

PRIMM OIL ENGINES. Distributed literature on the Primm low-pressure Diesel engine, with descriptive data, cost comparisons, and views of installations for distribution. *Representatives:* H. D. Swepston assisted by L. N. Hitchcock and E. J. Anderle.

GENERAL COLOR PRODUCTS CO. Showed a large assortment of coloring oxides and frits for use in enameling and decorating work. A large exhibit of decorated glass was shown. The company featured acid-proof colors. Literature describing the products was distributed.

CONSOLIDATED FELDSPAR CO. Joint exhibit with Golding Sons Co., Erwin Feldspar Co.

ERWIN FELDSPAR CO., INC. Booth contained finished articles in which Erwin products have been used, including terra cotta, abrasives, tile, pottery, porcelain, dishes, enamelware, and sanitary ware.

GOLDING SONS CO. shared this booth. *Representatives:* V. V. Kelsey, G. G. Hanson, C. F. Franzheim, J. D. Pearson, W. A. Seger, and Henry R. Schneider.

BABCOCK & WILCOX CO. Exhibit consisted of various types of refractory materials, made from the same kaolinic base. A block of raw clay as mined was shown, and also the several types of fired shapes manufactured from this clay. No. 80 refractory ce-

ment, moldable sagger grog, and baffle mix was on display. *Representatives:* J. E. Brinkerhoff assisted by H. J. Shaner.

THE PATTERSON FOUNDRY & MACHINE CO. Featured complete line of laboratory pebble mills in operation, as well as the Type "D" mills, both in belt-driven and motor-driven types. Working models of standard design showed the inside working of the new ball valve slip pump. Agitators and mixers were exhibited featuring the new worm-driven agitators.

AMERICAN GAS ASSOCIATION. Featured the new type of waterless gas holder, a model of the World's Largest Holder. The original of this holder is 283 ft. in diameter and 416 ft. high, from ground level to apex of main structure, surmounted by a 70-ft. light tower. The model holder rotated upon a table in order to facilitate the reviewing of 8 translucent photographs mounted on the sides and which showed recent industrial gas installations in the ceramic field. Vitreous enameling, brick firing, and frit melting were pictured. *Representatives:* R. A. Hastings, H. F. Rehfeldt and P. H. Dreyer.

U. S. GYPSUM CO. Samples of the various raw materials and finished products used industrially and made from gypsum and limestone, including pottery plaster, plate glass plaster, terra cotta plaster, terra alba, and other products. Technical experts explained to the visitors the use of these products. *Representatives:* R. B. Ladoo, J. J. Kelley, W. M. Myers.

THE LINK-BELT CO. Featured the highly mystifying Silent Chain Paradox, and showed a herringbone speed reducer (Sykes tooth form) and a vibrating screen model, together with elevating, conveying, and power transmission chain samples and belt conveyer idler assemblies. Interesting photographs showed heavy equipment, such as shovels, cranes, draglines, and the "Grizzly" crawler loader. *Representatives*: Paul Wheeler, L. A. Spillan, H. F. Weber, and H. L. Strube.

J. C. STEELE & SONS AND MANUFACTURERS EQUIPMENT CO. Showed mostly photographs of installations in various parts of the country, featuring particularly the latest machines Nos. 54 and 65. *Representative:* H. O. Steele.

PRECISION GRINDING WHEEL CO., INC. Exhibit especially designed to show application of the various types of abrasive products as applied to the ceramic industry. Various types of wheels, segments, special shapes, etc., used in the cutting, grinding, or shaping of all kinds of ceramic ware, from the hardest porcelain to the softest fire brick, were shown. *Representatives:* H. A. Plusch, A. S. Sandorff, W. P. Conant, and A. H. Benner.

BINKS SPRAY EQUIPMENT CO. Various types of spray guns with photographs and literature, explaining their use and operation on ceramic products. The wide use of this equipment in the ceramic industry was explained.

THE BROWN INSTRUMENT CO. Exhibited the following flush type instruments on black metal panel boards: Indicati ngresistance thermometer; strip chart recording resistance thermometer; indicating pyrometer with 12-point moistureproof switch; single record strip chart recording pyrometer; Diesel engine combined pyrometer and 12-point moistureproof switch; 4-record recording strip chart pyrometer; circular chart recording thermometer; strip chart recording thermometer; circular chart recording pressure gage; strip chart recording pressure gage indicating flowmeter; strip chart recording flowmeter. A portable pyrometer and portable potentiometer, base metal thermocouple, platinum thermocouple, sillimanite tube, flowmeter forged steel manometer and recording integrating flow meter were shown. *Representatives:* G. W. Keller, C. L. Saunders, R. W. Conwell, H. L. Pfaffhausen, and H. C. Beck.

THE PORCELAIN ENAMEL & MFG. CO. Showed a heating stove manufactured in Denmark and enameled in Pemco majolica enamel. The stove is odd in design, the castings representing a high type of workmanship and majolica enamel finish of the highest type. This particular enamel finish is applied by the wet-coat process. In contrast to this modern stove was the original stove used by Abraham Lincoln, the two exhibits serving to illustrate the advances made in this product in the last 60 years. *Representatives:* Richard H. Turk, Harold G. Wolfram, W. Russell Greer.

BROOKVILLE LOCOMOTIVE CO. A full-size Brookville 4-ton Model "IBS" locomotive, comprising the company's latest improved equipment was exhibited. *Representative:* W. E. Briggs.

A. P. GREEN FIREBRICK CO. Complete assortment of the different types of refractories manufactured was shown. Fired specimens of standard fire brick and special shapes used in various refractory applications in the ceramic industry were on display. Samples of the various grades of raw materials used in the manufacture of different types of refractories. Cross-sections of fire brick, showing the structure obtained by different processes of manufacture. Photographs and illustrations showing the methods of manu-

facture, firing in tunnel kilns, downdraft kilns, and other interesting processes at the plant were shown. Also a considerable amount of data was displayed for the general information of the ceramic industry. *Representatives:* J. Harrison Brown, H. J. Hoff, Orville A. Cost, Paul Slegel, and A. L. Diederich.

Carrier Engineering Corp. Chief exhibit was a standard ejector drier, so constructed that the principles of operation were seen. Also, a Thermotyme instrument used for wet and dry bulb temperature control in driers. Various pictures showing Carrier installations in the ceramic industry. *Representatives:* E. P. Heckel, H. B. Matzen, J. H. Bailey, D. C. Lindsay, W. H. Moler, H. M. Rudio, C. E. Parmelee, and R. Duncan.

Pennsylvania Pulverizing Co. Crude samples of rock, both silica and feldspar, fired samples of the feldspar, ground samples of silica and feldspar, as well as photographs of the Company's operations were displayed. *Representatives:* Robert F. Riddle, H. B. DuBois, and F. G. Lord.

The Hardinge Co. Exhibited a scene in action picture of the Hardinge conical mill with air classifier. Circulars, catalogs, and other literature for distribution were available.

The Texas Co. Exhibited a regular line of lubricating oils and greases, with full information on the use of these in clay products and ceramic plants. *Representatives:* N. H. Steindler and A. J. Herom.

Globar Corp. Various applications of the Globar heating unit were on display, and photographs showing the installation were exhibited. This company also distributed literature describing its products and uses in the ceramic industry.

Carborundum Co. The refractory division of this company featured a section of a complete Carbofrax muffle porcelain enameling furnace, showing method of supporting bottom and general construction of furnace. Enlarged photographs of unique types of kilns recently built for the firing of glazed ceramic bodies were shown. *Representatives:* R. A. Beverley, R. S. Baker, and S. A. Fenno.

Traylor Vibrator Co. Interesting exhibit showing the use of the Traylor vibrating screen and various separation problems. Samples of screen cloths, as well as photographs and literature descriptive of Traylor installations and performance.

Dings Magnetic Separator Co. An interesting exhibit, consisting of two operating magnetic separators. One of these machines is a wet type separator, removing iron from slip and glaze. The other is the Type B for handling dry materials, such as grog, sand, feldspar, etc. This machine is automatic. Demonstration of separation was made on typical materials. *Representatives:* J. L. Mayer, F. E. Oswald, E. S. Hirschberg, J. L. Hope, R. L. Johnstone, and R. A. Manegold.

Clark Tructractor Co. Showed a full-size Clark Truclift of special design for brick and ceramic products manufacturing, with spring suspended platform. Also a low auto dump Clark tructractor. *Representatives:* Walter Nochumson and R. F. Sutton.

Norton Co. Main part of exhibit consisted of large showcase containing samples of Norton ceramic products, including grinding wheels, refractories, and Norton floors. There were refractory materials of various kinds, including those used in laboratories, large commercial furnaces, electrical appliances, and activated sludge sewage plants. Special refractory products, such as the new patented corrugated plate for use in tunnel kiln combustion chamber walls, Alundum blocks for use in contact with molten glass, hearth plates for heat-testing furnaces, and Crystolon brick for boiler furnace walls, as well as refractory cement mixtures were shown. *Representatives:* R. Kirkpatrick, K. H. Bird, and H. A. Blackburn.

Illinois Testing Laboratories, Inc. Featured portable and prominent panel types of thermoelectric temperature measuring instruments, as well as portable and panel type resistance thermometers. Various types of thermocouples and other equipment of this nature. *Representatives:* J. A. Obermaier and E. DeBruyne.

The DeVilbiss Co. Featured the spray-finishing system used in the ceramic industry. This equipment consisted of a special spray booth used extensively in the finishing process where porcelain enamel is applied; spray guns, material containers, air and fluid hose, air transformer, handling devices, etc. Samples from a variety of customers using DeVilbiss equipment were on display.

Kentucky-Tennessee Clay Co. Raw clays and the various products in which they are used, including dinnerware, both white and ivory, floor and wall tile, hotel china, high tension insulators, sanitary ware, standard and special porcelain, and other products. *Representatives:* R. W. Greene and R. C. Meeker.

W. S. Tyler Co. Exhibited screens for use in the ceramic industries from 1-inch mesh to 300-mesh. *Representative:* F. P. Nickerson.

Thew Shovel Co. Photographs of installations picturing various sizes of shovels in the clay pits of the country. All necessary literature for complete description of the various features of Thew equipment.

The Bristol Co. This booth featured the BK motor valve in which considerable interest has been displayed. There were also on display a 6-record pyrometer with electric clock, representing the latest type of equipment; a No. 420 indicating pyrometer with 20-point switch; protection wells; double movement and double record pyrometer; model C-11 thermometer with a range of 40 to 600°; portable watt meter and draft gages. *Representatives:* H. E. Beane, L. G. Bean, and C. Worth.

Clearfield Machine Co. The booth contained a very interesting operating model of the new 100,000-lb. Clearfield Maximuller. This was as nearly as possible an exact duplicate, in miniature, of the world's largest dry pan.

Robertson & Co., Inc. Drawings and photographs of tunnel kilns, together with samples of products fired in representative installations. These samples consisted of floor, wall, faience, mat colored tile, hotel china, general ware, insulating brick, electrical refractories, and porcelains. *Representatives:* H. M. Robertson, A. L. Steger, and T. J. Guy.

The Deister Concentrator Co. Exhibited a complete screening plant, incorporating the Leahy No-Blind Vibrating Screen. The plant consisted of bucket elevator, 17 x 32 in., Leahy screen, and return screw conveyer. This plant is built up to be dustproof and operates automatically for continuous demonstration. It operates on a fine screening problem, sizing at 100-mesh. *Representatives:* N. Rhuné, C. W. Fugate, and Don A. Weber.

American Dressler Tunnel Kilns, Inc. Photographs, slides, and literature, showing successful installation and giving interesting information on the performance of Dressler tunnel kilns. *Representatives:* Philip Dressler, Thomas M. Low, H. E. Fear, Alfred Badowski, and L. A. Vincent.

New Castle Refractories Co. Featured a typical section of clay muffles used in Dressler tunnel kilns. Several shapes containing various proportions of silicon carbide, fused alumina, mullite, sillimanite, and showing how these materials can be formed into intricate shapes by the casting departments were shown. Shapes of panel tile, recuperator tile, fireclay protecting pyrometer tubes, tunnel kiln car superstructure, and various shapes of units used for supporting resistors in electrical furnaces of different types. Improved sagger or tile setter used with the muffle type of tunnel kiln. A few designs in the way of improving setters for dishes directly applicable to placing in tunnel kiln were shown. *Representatives:* Geo. D. Morris and Gordon Klein.

Chicago Vitreous Enamel Products Co. Educational exhibit, demonstrating the application of vitreous enamel and showing how vitreous porcelain enamels are applied to metal base. Equipment in the booth consisted of a small furnace and spraying apparatus used in the application of enamels. In addition to the educational exhibit there was an exhibit of products.

Alton Barium Products Co. A complete line of products, as well as a line of the different manufactured products in which Alton material is used. *Representatives:* M. E. Turner, D. M. Brandel, and E. N. Schwegel.

Claude S. Gordon Co. Showed pyrometers of all kinds with porcelain protection tubes and thermocouples, switch cabinets, and various types of switches. An all-electric furnace in full size was a feature. *Representatives:* R. Schoenfeld, A. W. Anderson, and Miss A. Frank.

Wilson-Maeulen Co. Indicating, recording, and automatic controlling pyrometer and electric resistance thermometer instruments of types in general use in ceramic and glass plants for the control of temperatures in kilns and driers of both periodic and continuous types. *Representatives:* M. A. Schreiner, C. E. Hellenberg, and G. B. Duff.

Corhart Refractories Co. The company manufactures mullite and other refractories, utilizing the casting process. Various samples of the product and other interesting material were on display.

Buckeye Clay Pot Co. Exhibited various refractory shapes used in the construction of glasshouse tanks and furnaces. Literature describing the products was given.

General Electric Co. These exhibits consisted of interesting displays, showing the application of the various products of this company to ceramic products manu-

facturing. Motors were featured, although samples of other products, as well as photographs and literature, were on hand.

WELLINGTON MACHINE CO. Wellington rubber tired wheels and casters, wheelbarrows and trucks, as well as literature and other descriptive matter applying to the products of this company were displayed. *Representatives:* C. W. Gannett, C. A. Glass, R. E. Hall, and V. W. Clisby.

LEEDS AND NORTHRUP CO. Showed complete operating exhibit of L. and N. Potientiometer pyrometer equipment, including automatic recorders, and optical pyrometers, together with the necessary accessories, and showing the use of these instruments in vaporproof cabinets. Complete data were given to those interested in understanding the value of the potientiometer principle employed in L. and N. pyrometers. *Representatives:* P. H. Taylor, M. B. Fisher, W. D. Trueblood, R. E. Hansen, and T. C. Bennett.

MARION STEAM SHOVEL CO. Showed panel with photographs of Marion machines in field service, as well as exhibit calling attention to the particular merit of the steels used in the manufacture of these machines.

CHAMBERS BROS CO. Showed variety of pictures, featuring the Chambers' equipment in operation at various high-class clay products plants. *Representatives:* Edw. E. Krauss and Frank S. Windolph.

W. A. RIDDELL CO. Featured the modernization idea in brick and clay plants, and exhibited its line of American clay machinery. *Representatives:* Robert N. Schaefer and others.

VOLCANIC SPECIALTIES CO. AND HOPKINS BROS. Joint exhibits showed oil burners for all kinds of ceramic work, mobile motor blowers for furnishing air blast, rotary circulating pump for oil supply, gravity pressure, regulator for maintaining uniform oil pressure, model of kiln showing oil-burning equipment installed, and one oil mill. Special interest centers around the oil mill, which is a device for mechanically treating fuel oil. This machine grinds and mills the heavy sludge, reducing it to free-flowing oil, and mixing it with the lighter oil to produce a free-flowing compound. The Duplex Mobile Blower is also extremely interesting, the duplex or double discharge feature of which makes it possible to pipe a kiln in both directions from the blower, a very distinct advantage. *Representatives:* C. R. Hopkins and Jas. H. Hopkins.

NOTES AND NEWS

Director of Research for Harbison-Walker

J. SPOTTS MCDOWELL

J. Spotts McDowell has been appointed Director of Research of the Harbison-Walker Refractories Company, Pittsburgh, Pa.

The scope of the company's research work will be broadened at the central laboratory in Pittsburgh while, in general, control work to insure uniformity of product will to a large extent be handled in the smaller laboratories at the individual plants.

Mr. McDowell, who has been connected with the Harbison-Walker Refractories Company for some twenty years, is well known to the refractories and allied industries through his contributions to technical literature and his activities in the AMERICAN CERAMIC SOCIETY, the American Society for Testing Materials, the American Refractories Institute, and other societies of which he is a member. He is a graduate of the Massachusetts Institute of Technology in Mining Engineering.

CERAMIC SCHOOL NOTES

Missouri Refractories Association Scholarship Awarded

E. T. HARVEY

Edwin T. Harvey, of Goldfield, Iowa, won the scholarship offered by the Missouri Refractories Association to the student having the most outstanding record in Ceramic Engineering at the School of Mines and Metallurgy at Rolla, Mo., during the present school year. This scholarship carries a remuneration of one hundred dollars.

Harvey is a senior at the School of Mines and Metallurgy and will receive his Bachelor of Science degree in Ceramic Engineering in the spring. He was also elected to Tau Beta Pi and Phi Kappa Phi.

The actual selection is based upon personality, character, loyalty, ability to mix, and such other qualities as go toward making a successful engineer. He has made an average grade of 90 during his six semesters in school. He is also a member of the senior council, the student governing body, and is vice-president of the Orton Society, whose purpose is the advancement and science of engineering pertaining to ceramics and its allied branches.

Ohio State University

F. P. Hall, Associate Chemist, U. S. Bureau of Standards, addressed the Student Branch, AMERICAN CERAMIC SOCIETY, on "Some Recent Developments in Methods and Equipment for Ceramic Research." Dr. Hall discussed modern methods used in studying the colloids of clays, including water adsorption, the supercentrifuge, and specific adsorption coefficient determination. He also discussed the measuring of fluidity and plasticity by the Bingham method, and the recent work in temperature-concentration study of the silicate systems. Dr. Hall is at present studying thermal expansion of ceramic bodies by means of the interferometer method and he briefly explained the operation of this apparatus.

The senior class in Ceramic Engineering sponsored a dance for all ceramic students on January 11.

H. Zane Schofield, chairman, Student Branch, AMERICAN CERAMIC SOCIETY, has appointed for the year 1929 the members of nominating, membership, refreshment, publicity, and program committees, and this student organization may be expected to show distinct activity during the coming year.

R. A. Snyder, who graduated in Ceramic Engineering in December, has accepted a position in the Ceramic Research Division of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.

James H. Page, who graduated in Ceramic Engineering in December, has accepted a position in the Enamel Department of the Estate Stove Co., at Hamilton, Ohio.

CALENDAR OF CONVENTIONS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY	February, 1930	Toronto, Canada
American Chemical Society	April 29–May 3, 1929	Columbus, Ohio
American Electrochemical Society	May 27–29, 1929	Toronto, Canada
	Sept. 18–20, 1929	Pittsburgh, Pa.
American Foundrymen's Assn.	April 8–11, 1929	Chicago, Ill.
American Gas Association (11th Annual Convention)	Oct. 14–18, 1929	Atlantic City, N. J.
The American Mining Congress (Practical Coal Operating Men and Natl. Exposition of Coal Mine Equipment)	May 13–17, 1929	Cincinnati, Ohio
American Refractories Institute	May 21, 1929	French Lick, Ind.
American Society of Mechanical Engineers	March 21–23, 1929	Knoxville, Tenn.
	May 13–16, 1929	Rochester, N. Y.
	July 1–4, 1929	Salt Lake City, Utah
	Dec. 2–6, 1929	Annual Meeting, New York
American Society for Testing Materials	June 24–28, 1929	Atlantic City, N. J.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Eastern Clay Products Assn.	March 12, 1929	Pittsburgh, Pa.
11th National Metal Exposition and National Metal Congress	Sept. 9–13, 1929	Cleveland, Ohio
Natl. Assn. of Mfrs. of Heating and Cooking Appliances	May 8–9, 1929	New York, N. Y.
National Clay Products Industries Assn.	April 15 or 16, 1929	Chicago, Ill.
National Glass Distributors Assn.	Dec. 3, 4, 5, 1929	Pitssburgh, Pa.
Natl. Safety Council's 18th Annual Safety Congress	Sept. 30–Oct. 4, 1929	Chicago, Ill.
Southern Clay Products Assn.	March 19, 1929	Atlanta, Ga.
Third International Foundrymen's Congress	June 10–13, 1929	London, England
Twelfth Exposition of Chemical Industries	Week of May 6th, 1929	New York City

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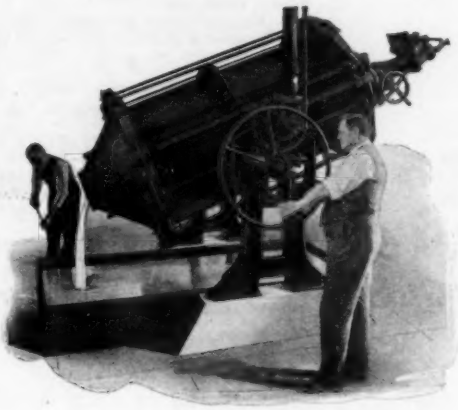

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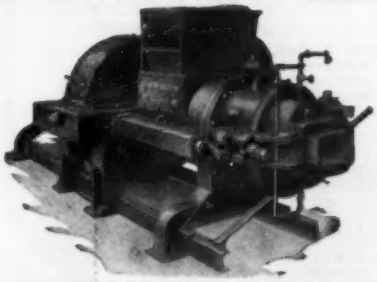

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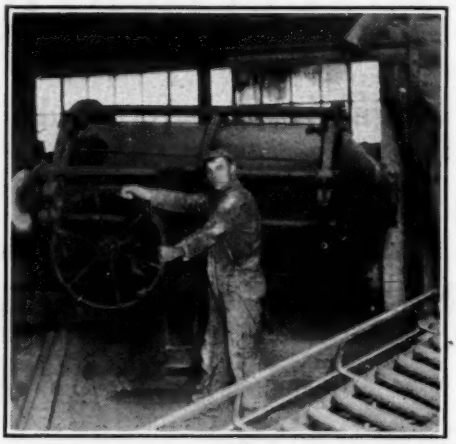

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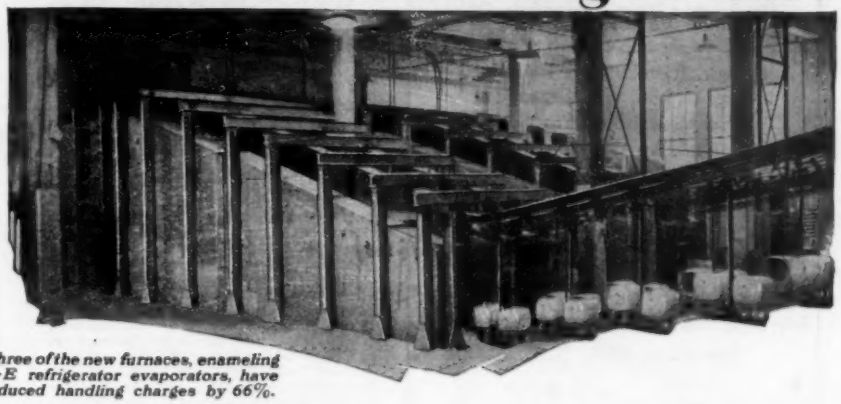

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